Doctor's
manual

The terminal part of the *internal pudendal artery* corresponds to that in the male and gives off the same branches, viz., the *artery to the bulb* (of the vestibule), the *deep artery of the clitoris* and the *dorsal artery of the clitoris.*

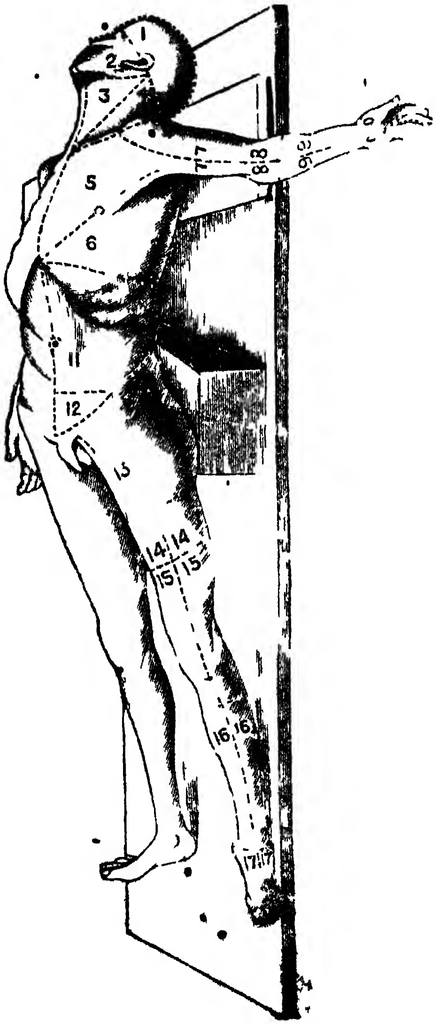
The *pudendal nerve* after giving off its perineal branch is continued as the *dorsal nerve of the clitoris* to the dorsum of the clitoris and is accompanied by the dorsal artery of the clitoris. The *dorsal vein of the clitoris* occupies the groove in the middle line of the dorsum of the clitoris.

THE ANTERIOR ABDOMINAL WALL.

The body is to be placed upon its back with blocks beneath the chest and pelvis. Devote three days to the dissection of this region.

Surface Anatomy.—The following landmarks should be recognised before the skin is reflected :—the symphysis pubis, the pubic tubercle, the anterior superior iliac spine, the crest of the ilium, the xiphoid process and the costal arch. The groove seen in the middle line from the xiphoid process to the symphysis pubis is the gap between the two recti muscles and corresponds to a longitudinal fibrous structure underneath called the linea alba. A little below its centre is seen the umbilicus or navel. If the rectus muscle is well developed, a curved line is seen at its lateral margin corresponding to the linea semilunaris, *i. e.*, the line of splitting of the aponeurosis of the internal oblique muscle. The spermatic cord should be felt and the ductus deferens lying at its back part can be easily recognised by its cord like feel.

Incisions :—(1) a longitudinal incision from the xiphoid process to the symphysis pubis along the middle line of the body ; (2) from the symphysis pubis along the inguinal ligament to the crest of the ilium and along it as far backwards as practicable ; (3) from the xiphoid process a trans-



1 Dissection of scalp.
2 of face.
3 of anterior triangle of neck
4 of posterior triangle of neck
5, 6 of pectoral region and axilla
7. of arm
8 of bend of elbow
9 of fore arm
10 of palm of hand
11 of anterior abdominal wall
12 of inguinal hernia
13 of femoral hernia and femoral triangle
14 of adductor canal
15 of front of lower part of thigh
16 of front of leg
17 of dorsum of foot

Fig. 3.—Anterior view of the body showing the lines of incisions for reflecting the integument.

verse incision around the chest as far back as possible; (4) a transverse incision from the anterior superior iliac spine towards the middle line. Reflect the skin flaps lateralwards.

A dissection of the anterior abdominal wall comprises the examination of the following structures :—

Fasciæ	1. Superficial fascia	Fascia of Camper. Fascia of Scarpa.
	2. Transversalis fascia.	
Muscles	1. Obliquus externus abdominis. 2. Obliquus internus abdominis. 3. Cremaster. 4. Transversus abdominis. 5. Rectus abdominis. 6. Pyramidalis.	
Vessels	1. Cutaneous vessels. 2. Subcostal and lower two intercostal arteries. 3. Abdominal branches of the lumbar arteries. 4. Inferior epigastric artery. 5. Deep circumflex iliac artery. 6. Superior epigastric artery.	
Nerves	1. Cutaneous nerves. 2. Lower six thoracic nerves. 3. Ilio-hypogastric. 4. Ilio-inguinal.	

The **Superficial Fascia** in the lower part of the abdomen below the level of the line drawn transversely medialwards from the anterior superior iliac spine is divisible into two layers, a superficial and a deep.

The *superficial layer* (*fascia of Camper*) is fatty and is continuous above with the superficial fascia covering the chest. Traced downwards it is continuous with the similar layer in front of the thigh. Traced downwards and medialwards it passes over the spermatic cord into the scrotum, where it changes its fatty character and forms the tunica dartos.

The *deep layer* (*fascia of Scarpa*) is stronger and more membranous than the superficial layer. In the inguinal region it is separable from the superficial layer by the superficial epigastric vessels and the inguinal lymphatic glands. Above it blends with the superficial layer. Below it blends with the fascia lata of the thigh just below the inguinal ligament. Below and medially it passes over the spermatic cord to the scrotum and then becomes continuous with the fascia of Colles in the perineum. These connections of the fascia of Scarpa are important as explaining the course taken by urine extravasated between the inferior fascia of the urogenital diaphragm and the fascia of Colles. The urine cannot pass down the thigh owing to the attachment of the fascia of Scarpa to the fascia lata. But it is free to pass upwards along the abdominal wall.

Cutaneous Nerves.—These are the anterior and lateral cutaneous branches of the lower five or six thoracic nerves and the cutaneous branches of the ilio-hypogastric and ilio-inguinal nerves. (1) The *anterior cutaneous branches of the lower five or six thoracic nerves* become cutaneous by piercing the sheath of the rectus near the middle line. These cutaneous branches are found to pass in company with the cutaneous arteries. (2) The *anterior cutaneous branch of the ilio-hypogastric nerve* pierces the aponeurosis of the external oblique muscle about an inch above the subcutaneous inguinal ring and supplies the skin of the hypogastric region. (3) The terminal part of the *ilio-inguinal nerve* becomes cutaneous through the subcutaneous inguinal ring and supplies the skin of the scrotum and the upper and medial side of the thigh. (4) The *lateral cutaneous branches of the last six thoracic nerves* become cutaneous between the digitations of the external oblique muscle and each divides into an anterior and a posterior branch except the lateral cutaneous branch of the last

thoracic nerve. The *anterior branches* pass forwards towards the rectus abdominis and the *posterior branches* pass backwards over the latissimus dorsi. (5) The *lateral cutaneous branch of the twelfth thoracic nerve* remains undivided and crosses the crest of the ilium about two inches behind the anterior superior iliac spine to supply the skin of the gluteal region. (6) The *lateral cutaneous branch of the ilio-hypogastric nerve* becomes cutaneous just above the crest of the ilium and crosses the crest behind the lateral cutaneous branch of the twelfth thoracic nerve. It supplies the skin of the gluteal region.

The **Cutaneous Vessels** accompany both the lateral and anterior cutaneous nerves. (1) Those accompanying the anterior cutaneous nerves are the branches of the superior and inferior epigastric arteries. (2) Those accompanying the lateral cutaneous nerves are the branches of the lower aortic intercostal arteries. (3) In the groin three cutaneous branches ascend from the femoral artery just below the inguinal ligament. These are :—(*a*) the *superficial external pudendal* which passes medialwards across the spermatic cord to supply the skin of the scrotum and penis ; (*b*) the *superficial epigastric artery* which crosses the inguinal ligament about its middle and passes upwards towards the umbilicus ; and (*c*) the *superficial circumflex iliac artery* which sends a few twigs to the skin near the anterior superior iliac spine.

Remove the cutaneous vessels and nerves and also the superficial fascia. The obliquus externus abdominis is fully exposed, which should be cleaned.

The **Obliquus Externus Abdominis*** arises by eight fleshy digitations from the outer surfaces and lower borders of the lower eight ribs : of these the upper five interdigitate with the serratus anterior and the lower three with the latissimus dorsi. It is inserted by its posterior fleshy fibres into (1) the anterior half of the outer lip of the

iliac crest and by an aponeurosis into (2) the linea alba, (3) the front of the symphysis pubis, (4) the pubic tubercle, (5) the first inch of the pecten pubis (Ilio-pectineal line), and (6) the anterior superior iliac spine. It is supplied by the lower thoracic nerves.

The upper and middle fibres of the external oblique muscle pass downwards and forwards and end in an aponeurosis, called the *aponeurosis of the external oblique*, opposite a line drawn from the costal cartilage of the ninth rib to the anterior superior iliac spine. It passes medialwards in front of the rectus abdominis and meets its fellow of the opposite side at the linea alba. *Above* it gives origin to the pectoralis major. *Below* it forms a thickened band extending from the anterior superior iliac spine to the pubic tubercle and is known as the *inguinal ligament.* From the pubic tubercle some of the fibres are reflected to the pecten pubis forming the *lacunar ligament* and thence as a diverging triangular band called the *reflected inguinal ligament.*

Subcutaneous Inguinal Ring.—Notice that the aponeurosis of the external oblique is pierced just above the pubic crest by the spermatic cord in the male and the round ligament of the uterus in the female. The aperture formed in this manner is called the *subcutaneous inguinal ring* (External abdominal ring). From the margin of the opening a fascial prolongation is continued over the spermatic cord or the round ligament, called the *intercrural fascia* or the *external spermatic fascia.* Divide this fascia and note that the opening is triangular in shape with its base at the pubic crest. The margins of the opening are called the *crura of the ring.* The *superior crus* (inner pillar) is thin and is attached to the front of the symphysis pubis. The *inferior crus* (outer pillar) is thick and is formed by the lower end of the inguinal ligament and upon it the spermatic cord rests. The ring is smaller in the female than

in the male. Near the apex of the opening some arched fibres will be noticed passing from the lateral to the medial side. These are called the *intercrural fibres* and are continued downwards into the external spermatic fascia.

Detach the digitations of the external oblique from the ribs. Then divide its attachment to the crest of the ilium. Next divide it transversely from the anterior superior iliac spine to the lateral border of the rectus and carry the incision downwards along the lateral edge of the rectus muscle to the pubis and reflect the triangular piece of aponeurosis below the transverse incision downwards on the thigh. The parts concerned with the dissection of the inguinal hernia include this triangular aponeurosis and the structures situated beneath it. Reflect the remaining part of the external oblique forwards up to the lateral edge of the rectus. The following parts of the aponeurosis of the external oblique may now be studied :—

(1) The *inguinal ligament* (*Poupart's ligament*) is the thickened lower margin of the aponeurosis of the external oblique muscle extending from the anterior superior iliac spine to the pubic tubercle. It is slightly curved with the convexity of the curve directed towards the thigh where the fascia lata is attached. To the grooved concavity above are attached the internal oblique and cremaster muscles.

(2) The *lacunar ligament* (*Gimbernat's ligament*) is that part of the aponeurosis of the external oblique which is reflected from the pubic tubercle backwards and lateralwards for about an inch into the pecten pubis. On raising the medial end of the inguinal ligament it is found to be triangular in shape with its apex at the pubic tubercle; its base is concave and forms the medial boundary of the femoral ring. Its anterior border is continuous with the medial end of the inguinal ligament and its posterior border is attached to the pecten pubis.

(3) The *reflected inguinal ligament* (*Triangular fascia of the abdomen*) is a triangular aponeurosis which extends from the lacunar ligament to the linea alba. It passes upwards and medialwards behind the spermatic cord and the superior crus of the subcutaneous inguinal ring to be continuous with the ligament of the opposite side at the linea alba.

Clean the surface of the internal oblique muscle taking care of the nerves which pierce it.

The **Obliquus Internus Abdominis** takes origin (1) from the grooved concavity of the inguinal ligament in its lateral half; (2) from the anterior two-thirds of the intermediate lip of the iliac crest; and (3) from the lumbodorsal fascia. The muscle is inserted (1) into the lower borders of the cartilages of the tenth, eleventh and twelfth ribs by fleshy fibres; (2) into the lower borders of the cartilages of the seventh, eighth and ninth ribs and into the lateral border of the xiphoid process by an aponeurosis; (3) into the whole length of the linea alba (aponeurotic); and (4) into the pubic crest and first half an inch of the pecten pubis by a blended aponeurosis called the inguinal aponeurotic falx.

Direction of fibres :—(1) the fibres from the inguinal ligament pass downwards and medialwards in front of the spermatic cord or round ligament and become blended with those of the transversus abdominis forming the *inguinal aponeurotic falx*; (2) the fibres from the anterior third of the iliac crest pass horizontally medialwards to end in an aponeurosis at the lateral edge of the rectus; (3) the fibres from the middle third of the iliac crest pass upwards and medialwards.

The *aponeurosis of the internal oblique muscle* should now be traced. At the lateral edge of the rectus muscle it will be found to split in the upper three-fourths of its extent into two layers, an anterior and a posterior. The

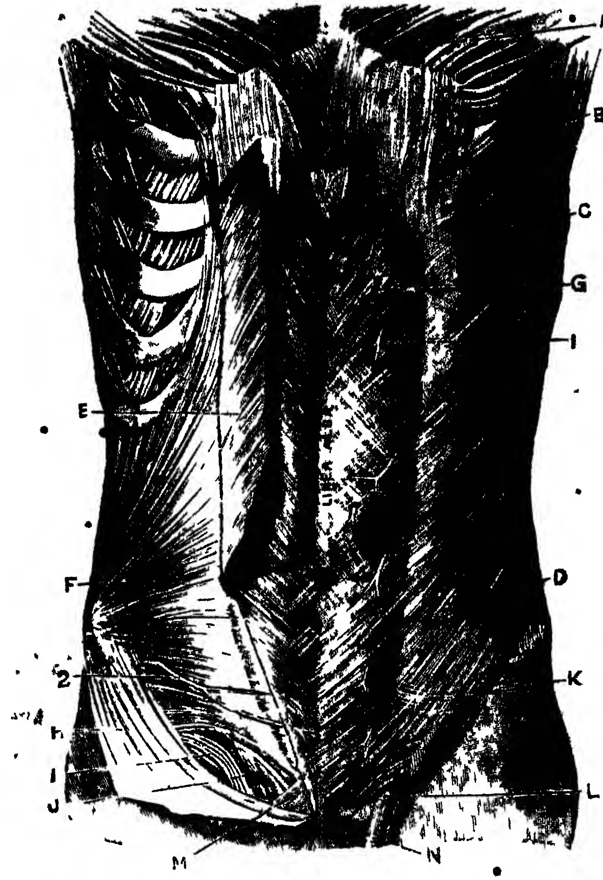


Fig. 4.—Dissection of the anterior wall of the abdomen. (Cunningham.)

A. Pectoralis major.
B. Serratus anterior.
C. Obliquus externus abdominis.
D. Aponeurosis of external oblique muscle.
E. External oblique muscle (thrown forwards.)
I. Cremaster.
J. Inguinal aponeurotic falx.
K. Intercrural fibres.
L. Subcutaneous inguinal ring.
M. Reflex ligament of Colles.
N. Spermatic cord.

F. Obliquus internus abdominis.
G. Sheath of rectus abdominis.
H. Aponeurosis of external oblique (reflected).
1. Anterior cutaneous nerve.
2. Anterior cutaneous branch of ilio-hypogastric.

anterior layer passes in front of the rectus and blends with the aponeurosis of the external oblique. The posterior layer passes behind the rectus and blends with the aponeurosis of the transversus abdominis lying underneath. In the lower fourth of its extent the aponeurosis passes entirely in front of the rectus blending with that of the external oblique.

The obliquus internus abdominis is supplied by the lower thoracic nerves and the ilio-hypogastric nerve.

The **Cremaster** is the continuation below of the internal oblique and is spread over the spermatic cord. It arises from the grooved concavity of the inguinal ligament at about its middle. It descends on the front and lateral aspects of the spermatic cord forming muscular loops. When the scrotum is dissected these loops will be found to descend as low as the tunica vaginalis testis. Some of these loops are inserted (1) into the tunica vaginalis; others ascend along the medial aspect of the cord to be inserted (2) into the pubic tubercle; (3) into the pubic crest; and (4) into the front of the sheath of the rectus. The muscular loops on the spermatic cord are bound together by areolar tissue forming a thin fascia called the *cremasteric fascia.*

The cremaster is supplied by the external spermatic branch of the genito-femoral nerve which will be observed entering the deep surface of the muscle when it is reflected.

Reflect the whole of the internal oblique muscle forwards towards the lateral edge of the rectus. Give a vertical incision from the tip of the last rib to the iliac crest and extend it upwards along the costal arch. Next cut through the muscle where it is attached to the iliac crest and the inguinal ligament. An ascending branch

of the deep circumflex iliac artery runs between the internal oblique and the transversus abdominis near the anterior part of the iliac crest and the inguinal ligament, and serves as a guide for separating the two muscles from one another. Divide the cremaster by a longitudinal incision over the spermatic cord and reflect it on either side. While reflecting the internal oblique muscle forwards note that the lateral cutaneous nerves with blood vessels are piercing the muscle at its back part.

Nerves of the Anterior Abdominal Wall.—(1) The *lower six thoracic nerves* pass forwards between the internal oblique and the transversus muscles to enter the sheath of the rectus; piercing it, they form the anterior cutaneous nerves. (2) The *ilio-hypogastric nerve* pierces the posterior part of the transversus muscle a little above the crest of the ilium. It then passes forwards between the internal oblique and the transversus and gives off the *iliac branch* which has been seen to pierce the internal and external oblique muscles and to cross the iliac crest for distribution in the gluteal region. The main trunk of the nerve then continues its course forwards and downwards between the internal oblique and the transversus; and supplying them, pierces the former muscle in front of the anterior superior iliac spine. Its final distribution after piercing the aponeurosis of the external oblique about an inch above the subcutaneous inguinal ring has been already noted. (3) The *ilio-inguinal nerve* will be seen piercing the transversus abdominis near the anterior part of the iliac crest. Then it passes between the internal oblique and the transversus abdominis, supplies both the muscles and communicates with the ilio-hypogastric nerve. It then pierces the lower fibres of the internal oblique and passes through the subcutaneous inguinal ring to become cutaneous which has already been noted.

The Transversus Abdominis (Transversalis) arises from

(1) the lateral third of the inguinal ligament, (2) the anterior two-thirds of the inner lip of the iliac crest, (3) the lumbo-dorsal fascia and (4) the inner surfaces of the cartilages of the lower six ribs interdigitating with the origin of the diaphragm. It is inserted by means of its aponeurosis into (1) the linea alba, and by the inguinal falx into (2) the pubic crest, and (3) the pecten pubis. The direction of the fibres of the muscle is mostly transverse. It is supplied by the lower six thoracic nerves, the ilio-hypogastric and ilio-inguinal nerves.

It should be noticed that the transversus abdominis ends in front in an aponeurosis, called the *aponeurosis of the transversus abdominis.* The lower fibres of the aponeurosis pass downwards and medialwards and blend with those of the internal oblique forming the falx inguinalis. The rest of the aponeurosis passes forwards to be inserted into the linea alba, and it should be noted, that its upper three-fourths pass behind the rectus and blend with the posterior lamella of the aponeurosis of the internal oblique ; its lower fourth passes in front of the rectus.

The *inguinal aponeurotic falx* (Conjoined tendon) is the common aponeurotic insertion of those fibres of the internal oblique and the transversus abdominis which arise from the inguinal ligament. The transversus abdominis contributes to the formation of the greater part of the falx.

Divide the anterior wall of the sheath of the rectus by a vertical incision and reflect the flaps by dividing the adhesions between the sheath and the tendinous intersections in the muscle.

The **Rectus Abdominis** arises (1) from the crest of the pubis (outer head) and (2) from the front of the symphysis pubis (inner head) by tendinous fibres. It is inserted by three slips into the anterior surfaces of the cartilages of the fifth, sixth and seven ribs. The muscle is broad above

Fig. 5.—Muscles of the anterior abdominal wall. The inguinal canal has also been laid open. (Altered from Wood.

External oblique (reflected).	F. Fascia transversalis.
Internal oblique (cut).	G. Infundibuliform fascia.
Transversus abdominis.	H. Cremaster.
Rectus abdominis.	I. Spermatic cord.
Inguinal aponeurotic falx.	

and narrow below and consists of vertical fibres which are interrupted usually in three situations by tendinous intersections, called the *inscriptiones tendineæ*. They have a zig-zag course and run transversely; one is situated opposite the umbilicus; the second is opposite the xiphoid process; and the third midway between these two. A fourth one, when present, is seen below the umbilicus.

They are firmly adherent to the anterior wall of the sheath of the rectus. The rectus abdominis is supplied by the lower six thoracic nerves.

The **Pyramidalis** is a small pyramid-shaped muscle which lies in front of the lower part of the rectus. It arises by its base from (1) the pubic crest and (2) the symphysis pubis, and is inserted by its apex into the linea alba. This muscle is sometimes absent. The twelfth thoracic nerve will be seen to enter the deep surface of the muscle and supply it.

The **Sheath of the Rectus** is formed by the aponeuroses of the two oblique muscles and the transversus abdominis. It consists of two walls, an anterior and a posterior. The *anterior wall* is formed throughout its entire extent by the aponeurosis of the external oblique which is strengthened in addition over the upper three-fourths of the rectus by the anterior lamella of the aponeurosis of the internal oblique. Over the lower fourth of the rectus the aponeurosis of the external oblique is strengthened by fusion with the undivided aponeurosis of the internal oblique and the aponeurosis of the transversus. The *posterior wall* of the sheath is deficient above where the muscle rests on the xiphoid process and the cartilages of the fifth, sixth and seventh ribs. It is also deficient below behind the lower fourth of the rectus where the undivided aponeurosis of the internal oblique together with the aponeurosis of the transversus abdominis passes in front of the muscle. In the intermediate portion the posterior wall is formed by the blending of the posterior lamella of the aponeurosis of the internal oblique and the aponeurosis of the transversus abdominis. Below the posterior wall ends in a free crescentic margin with its concavity directed downwards, which is called the *linea semicircularis* (Semilunar fold of Douglas). The lower thoracic nerves pierce the posterior wall in their course to supply the rectus and then

become cutaneous. Inside the sheath of the rectus are seen the rectus abdominis, the pyramidalis, the lower six thoracic nerves and the superior and inferior epigastric arteries.

The **Linea Alba** should now be examined fully. It is a fibrous raphe seen in the middle of the anterior abdominal wall, and attached above to the tip of the xiphoid process and below to the symphysis pubis. It is formed by the blending of the aponeuroses of the oblique and the transverse muscles of opposite sides and is broader above than below. Several small apertures can be seen in it for the passage of vessels and nerves. The largest aperture is at the site of the umbilicus and is closed in the adult.

Reflect the transversus abdominis by detaching it from the inguinal ligament and the iliac crest. Detach the muscle from the lumbo-dorsal fascia by a vertical incision and carry the incision upwards obliquely along the costal arch. The whole muscle can then be reflected forwards. The fascia transversalis is exposed.

The **Fascia Transversalis** is a thin aponeurosis which lies between the transversus abdominis and the extra peritoneal fat. *Above* it is thin and is lost in the areolar tissue on the under surface of the diaphragm. *Below* it is attached to the inner lip of the iliac crest; from the anterior superior iliac spine to the femoral vessels it is attached to the posterior aspect of the inguinal ligament and is there continuous with the fascia iliaca; in front of the femoral vessels it is prolonged into the thigh as the anterior layer of the femoral sheath; medial to the femoral vessels it is attached to the pecten pubis behind the attachment of the inguinal falx. *In front* it is continuous with the fascia of the opposite side. *Behind* it is lost in the fat covering the posterior surface of the kidney. Below the lower margin of the transversus abdominis

the fascia is thick and is pierced by the spermatic cord in the male and the round ligament in the female. This opening in the fascia transversalis is called the *abdominal inguinal ring* (internal abdominal ring). It is situated about half an inch above the mid point of the inguinal ligament. It should be noted that the ring is not an open aperture in as much as a fascial prolongation is continued over the spermatic cord or the round ligament from the margin of the ring. This prolongation, called the *infundibuliform fascia*, is funnel-shaped and can be rendered tense and prominent by pulling the cord.

The **Inguinal Canal** is an oblique canal about an inch and a half in length and gives passage to the spermatic cord in the male and the round ligament in the female. It begins above at the abdominal inguinal ring and ends below at the subcutaneous inguinal ring. Its *anterior wall* is formed by (1) the skin, (2) the superficial fascia, (3) the aponeurosis of the external oblique, and (4) the internal oblique which covers the upper third of the canal only. Its *posterior wall* or *floor* is formed by (1) the reflected inguinal ligament, (2) the inguinal aponeurotic falx, (3) the fascia transversalis, (4) the extraperitoneal fatty tissue, and (5) the peritoneum.

ANATOMY OF THE PARTS CONCERNED IN INGUINAL HERNIA.

Incisions.—(1) A transverse incision from the anterior superior iliac spine to the linea alba. [illegible] incision from the termination of the first [illegible] the linea alba to the symphysis pubis (Fig. 3). [illegible] the triangular flap of skin towards the thigh as also the corresponding superficial fascia in two layers beneath it. The corresponding triangular piece of aponeurosis of the external oblique muscle is to be reflected

towards the thigh. The subcutaneous inguinal ring and the structures connected with it are to be preserved. Divide the internal oblique at its origin from the inguinal ligament. The ascending branch of the deep circumflex iliac artery will serve as a guide for the depth of the incision. Reflect the internal oblique medialwards. Divide the cremaster on the surface of the spermatic cord and reflect it on either side. The spermatic cord covered by the infundibuliform fascia which is prolonged from the margin of the abdominal inguinal ring is now exposed. The boundaries and contents of the inguinal canal should now be thoroughly examined.

The **Arteries of the Abdominal Wall** are now exposed and should be studied.

The *lower two intercostal arteries* run through the tenth and eleventh intercostal spaces, and pass forwards between the internal oblique and the transversus abdominis. They anastomose with the superior and inferior epigastric arteries. They have been observed accompanying the thoracic nerves.

The *subcostal artery* accompanies the last thoracic nerve and anastomoses with the last intercostal, first lumbar and superior epigastric arteries.

The *abdominal branches of the lumbar arteries* pass forwards be[illegible] the internal oblique and the transversus and anast[illegible] with the intercostal arteries, the deep circumfle[illegible] artery and the inferior epigastric artery.

Infer[illegible]gastric artery [illegible]—Its terminal [illegible]s been se[illegible] while the [illegible]ing port[illegible] fascia transversalis wh[illegible] external iliac artery about one-[illegible] inguinal ligament. At first it [illegible] medialwards and upwards along the medial side of the

abdominal inguinal ring lying between the peritoneum and the fascia transversalis. Then it pierces the fascia transversalis and crosses over the linea semicircularis to the interior of the sheath of the rectus. Inside the sheath the artery ascends behind the rectus, supplies branches to it and anastomoses with the superior epigastric artery. As the artery passes to the rectus muscle it forms the boundary of a triangular space called *Hesselbach's triangle* ; the other two sides of the triangle being formed by the lateral edge of the rectus and the inguinal ligament. The *branches* given off from the inferior epigastric artery are :—(1) the *external spermatic artery* (cremasteric artery) which supplies the cremaster muscle by entering its deep surface ; (2) the *pubic artery* which passes medialwards to the back part of the pubis and anastomoses with the pubic branch of the obturator artery ; (3) the *muscular branches* which supply the rectus by entering its deep surface ; (4) the *cutaneous branches* which pierce the rectus and the anterior wall of its sheath to supply the skin.

The *deep circumflex iliac artery* arises from the external iliac artery opposite the origin of the inferior epigastric artery. It passes upwards and lateralwards behind the inguinal ligament between the peritoneum and the fascia transversalis. At the anterior superior iliac spine it pierces the fascia transversalis and passes backwards between it and the transversus along the iliac crest to its middle. It then pierces the transversus and terminates between it and the internal oblique. Near the anterior superior iliac spine it gives off an *ascending branch*, which pierces the fascia transversalis and the transversus abdominis and then ascends between the latter and the internal oblique.

The *superior epigastric artery* is one of the terminal branches of the internal mammary artery. Near the posterior aspect of the seventh costal cartilage it enters

the sheath of the rectus, supplies the muscle and anastomoses with the inferior epigastric artery.

Reflect the fascia transversalis by detaching it from the inguinal ligament and the iliac crest. Give a longitudinal incision on the infundibuliform fascia covering the spermatic cord and reflect the fascia on either side.

The *extra-peritoneal fatty tissue* which intervenes between the fascia transversalis and the peritoneum is now exposed. It is scanty on the antero-lateral region of the abdominal wall and is found to be prolonged over the spermatic cord beneath the infundibuliform fascia.

SCROTUM, SPERMATIC CORD, TESTIS AND PENIS.

The dissection of the scrotum and the penis should be taken up next as they tend to dry up soon.

The **Scrotum** is a cutaneous pouch containing the testes and the lower portions of the spermatic cords. The skin is of a dark colour and divided into two halves by a median raphe. Hook down the testis and reflect the skin by giving a vertical incision from the region of the subcutaneous inguinal ring. The superficial fascia consisting of two layers and containing unstriated muscle fibres is now exposed. It is called the *dartos tunic*. These two layers of superficial fascia are continuous with the similar layers found in the groin and the perineum. It should be noticed that the testis and the spermatic cord within the scrotum are covered by (1) the external spermatic fascia, (2) the cremasteric fascia, and (3) the infundibuliform fascia. Reflect the external spermatic fascia by a longitudinal incision and note that it is continuous with the margin of the subcutaneous inguinal ring. Divide the cremasteric fascia by a similar incision and trace its continuity through the subcutaneous inguinal ring with the cremaster muscle in the inguinal region.

Reflect the infundibuliform fascia and note that it is continuous with the fascia transversalis at the margin of the abdominal inguinal ring. Beneath this layer is a layer of connective tissue continuous with the extra-peritioneal fatty tissue.

Spermatic Cord.—Its constituent parts may now be examined. These are (1) the ductus deferens, (2) the testicular artery, (3) the artery to the ductus deferens, (4) the testicular veins, (5) the external spermatic nerve, (6) sympathetic nerve filaments and (7) lymphatic vessels. These structures are connected together by loose areolar tissue.

The *ductus deferens* (vas deferens) is the excretory duct of the testis. It begins at the lower end of the testis and ascends behind the other constituents of the cord to the abdominal inguinal ring. It can be readily recognised by its hard cord like feel. The *testicular artery* (spermatic artery) is a branch of the abdominal aorta. It issues out of the abdomen through the abdominal inguinal ring, passes through the inguinal canal in company with the other constituents of the spermatic cord and proceeds to the testis and epididymis which it supplies. The *artery to the ductus deferens* is a small artery coming from the superior vesical branch of the hypogastric artery. It passes along the surface of the ductus deferens. The *testicular veins* issue from the back part of the testis. As they pass up the cord they form a plexus, called the *pampiniform plexus.* From it two veins emerge and pass up the inguinal canal, which finally unite to form a single vein. This vein will be seen during the dissection of the abdominal cavity, to open into the inferior vena cava on the right side and into the renal vein on the left side. The *external spermatic nerve* is a branch of the genito-femoral nerve. It has been seen to enter the deep surface of the cremaster.

The *sympathetic nerve filaments* accompany the testicular artery. The *lymphatic vessels* accompany the blood vessels.

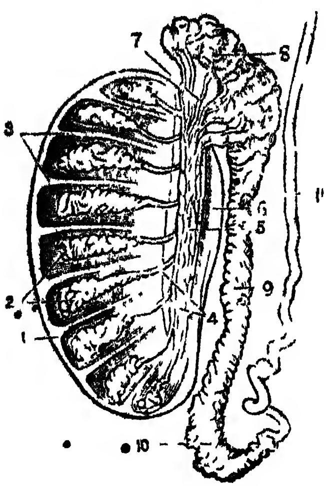
Divide the spermatic cord at the level of the subcutaneous inguinal ring and remove the testis from the body. Place the testis on a wooden block with the cord lying posteriorly and fix it with pins.

The **Testis** is a glandular body which developed primarily in the abdominal cavity but descended into the scrotum before birth. In its descent it carried with it a process of peritoneum lining the abdominal cavity, called the *processus vaginalis,* which remained patent over the testis as the *tunica vaginalis testis,* but became obliterated in the inguinal canal, being represented only by a fine fibrous cord. If a vertical incision is given over the anterior aspect of the testis the sac of the tunica vaginalis will be opened. It consists of a parietal and a visceral portion. The *parietal portion* is loose, lines the scrotum and is carried over the spermatic cord for about half an inch. It is continuous with the visceral layer along the posterior border of the testis. The *visceral portion* covers the body of the testis except at its posterior border. It also lines the side of the epididymis which lies on the lateral side of the testis. A pouch of the visceral layer is seen between the body of the testis and the epididymis, called the *sinus of the epididymis* (digital fossa). Hydrocele fluid collects in the sac of tunica vaginalis. Each testis is an oval body presenting two surfaces, two borders and two extremities. Its surfaces are medial and lateral and are more or less flattened. Its anterior border is convex. Its posterior border is flat and attached to the epididymis. Its upper pole in the living subject is inclined a little forwards and presents anteriorly two minute bodies called the *appendices testis* (hydatids of Morgagni). These structures are the remains of the Mullerian duct found in the foetus.

One of these bodies is usually stalked and the other is sessile. Its lower end is inclined a little backwards.

The **Epididymis** is an elongated body attached to the upper end and lateral part of the posterior border of the testis. It consists of three parts: (1) the *head* or *caput epididymis* (globus major), which is the upper enlarged portion lying over the upper end of the testis and is connected with it by efferent ducts called the *ductuli efferentes*; (2) the *body of the epididymis*, which is free and is separated from the body of the testis by the sinus epididymis; (3) the *tail of the epididymis* (globus minor), which is its lower end and is attached to the posterior border of the testis by areolar tissue. The epididymis terminates in the ductus deferens which passes upwards along the posterior border of the testis medial to the body and head of the epididymis.

Observe the branches of the testicular vessels entering into and issuing from the posterior border of the testis. Peel off the visceral layer of the tunica vaginalis from the testis. Another fibrous covering is now seen underneath. This is the *tunica albuginea*. Divide the tunica albuginea and the substance of the testis by a longitudinal incision and reflect the tunic backwards towards the posterior border of the testis. Here the tunica albuginea sends forwards a vertical septum called the *mediastinum testis* (corpus Highmori). By gently squeezing out the glandular substance many septa will be found passing from the mediastinum testis and dividing the glandular mass into a number of lobules. Inside these lobules the glandular mass can be drawn out into fine thread like structures called *tubuli seminiferi*. These tubules after a convoluted course in each lobule pass towards the mediastinum testis and join with each other to form about twenty or thirty straight tubules called the *tubuli recti*. These tubuli recti enter the medias-



1. Tunica albuginea.
2. Lobules of the testis.
3. Septa between the lobules.
4. Vasa recta
5. Rete testis.
6. Mediastinum testis.
7. Ductuli efferentes.
8. Head of epididymis.
9. Body of epididymis.
10. Tail of epididymis.
11. Ductus deferens.

Fig. 6.—Vertical section of the testis. (After Wilson.)

tinum testis and form a network of anastomosing tubes called the *rete testis*. These again end in about twelve to twenty ducts called the *ductuli efferentes* which become convoluted and form conical masses in the head of the epididymis called the *lobules of the epididymis* (coni vasculosi). These ductules then all open into a single tube, the duct of the epididymis, which becomes much coiled on itself to form the body and tail of the epididymis. If the tunica vaginalis is removed from the body and tail of the epididymis and the fibrous tissue binding the coils is cleaned, a greater part of the duct may be uncoiled.

The **Penis** consists of an extremity, or *glans penis*, a *body*, and a *root*. At the extremity the skin is doubled on itself and passes backwards to the base of the glans, and is thence reflected on the surface of the glans to be continuous with the mucous membrane of the external urethral orifice. This loose fold of skin is called the

prepuce. Below the urethral orifice a triangular fold passes to the prepuce. This is called the *frenulum preputii.*

Give a longitudinal incision along the middle line of the dorsum of the penis and reflect the skin on either side.

The *superficial fascia* covering the penis is also divisible into two layers which are continuous with the similar layers of the anterior abdominal wall and scrotum. Like the tunica dartos of the scrotum it contains involuntary muscle fibres and is devoid of fat.

The *suspensory ligament of the penis* is a triangular band composed of fibrous and elastic tissue. It is attached by its apex to the front of the symphysis pubis. Its base splits into two laminæ which are attached to the deep fascia of the penis. Between the two laminæ the dorsal vessels and nerves of the penis pass.

The *deep fascia of the penis* covers the dorsal vessels and nerves of the organ and extends forwards up to the glans. It receives the aponeurotic insertions of the ischio-cavernosus and the bulbo-cavernosus.

The *deep dorsal vein of the penis* is formed by minute veins from the glans. It passes backwards in the groove along the middle line of the dorsum of the penis, and then between the two laminæ of the suspensory ligament. Then it sends a communicating twig to the internal pudendal vein and enters the pelvis below the pubic arcuate ligament to join the pudendal venous plexus.

The *dorsal arteries of the penis* are the terminal branches of the internal pudendal artery. They pass forwards to the glans on either side of the deep dorsal vein.

The *dorsal nerves of the penis* are the terminal branches of the pudendal nerve. They pass forwards on the lateral side of the dorsal arteries.

Structure of the body of the penis.—Structurally the penis consists of the two *corpora cavernosa penis* situated dorsally and ending behind the glans in a blunt rounded

extremity. Their under surface presents a median longitudinal groove along which the *corpus cavernosum urethræ* lies, which ends in front in an expanded extremity forming the *glans penis* and presents an enlargement behind called the *bulb of the urethra.* The cavernous portion of the urethra is about six inches in length and terminates at the external urethral orifice at the summit of the glans. The raised margin at the base of the glans is called the *corona glandis.*

The *root of the penis* is formed by the two diverging corpora cavernosa penis. Their attachment to the rami of the ischium and os pubis has already been noted.

The *corpora cavernosa penis* are enclosed by a strong fibrous capsule. From the inner surface of this capsule a vertical septum descends separating the two halves, called the *septum of the penis.* As this septum is incomplete in its front part where it is seen as vertical bands arranged like the teeth of a comb it is called the *septum pectiniforme.* From the inner surface of the capsule and the septum processes or trabeculæ pass to the erectile structure of the corpora cavernosa penis subdividing it into venous spaces. Incisions may be made into the corpora cavernosa penis to note their spongy structure. The fibrous capsule of the corpus cavernosum urethræ is thin and sends trabeculæ from its inner surface.

THE ABDOMINAL CAVITY.

Remove the remains of the sheath of the rectus and the fascia transversalis. The peritoneum is now well exposed. The cavity of the abdomen is to be opened by a vertical cut through the peritoneum from the umbilicus to the xiphoid process a little to the left of the middle line and by a transverse incision at the level of the umbilicus. Reflect the upper two flaps on the costal arch.

Raise the lower flap by holding it at the centre of its free margin.

The following elevations and depressions are found on the posterior aspect of the anterior abdominal wall :—

(1) The *median umbilical fold* covers the middle umbilical ligament or the urachus and extends from the apex of the bladder to the umbilicus. (2) The *lateral umbilical folds* cover the obliterated umbilical arteries and extend from the umbilicus to the sides of the bladder, one on each side of the medial umbilical fold. (3) The *epigastric folds* lie to the lateral side of the lateral umbilical folds. They cover the inferior epigastric arteries as they proceed towards the umbilicus.

Three *peritoneal fossæ* or shallow depressions are seen on either side of the middle line bounded by these peritoneal folds. They lie close to the inguinal ligament. The medial one is called (*a*) the *supravesical fossa* and lies between the median and lateral umbilical folds. The intermediate one is called (*b*) the *medial inguinal fossa* and lies between the lateral umbilical fold and the epigastric fold. These two fossæ are situated in the triangular space called Hesselbach's triangle. The lateral fossa is called (*c*) the *lateral inguinal fossa* and is situated lateral to the epigastric fold and the inferior epigastric artery. The depression here corresponds to the abdominal inguinal ring and if any of the contents of the abdominal cavity protrudes through this lateral inguinal fossa it will push the peritoneal pouch in front of it and enter the inguinal canal through the abdominal inguinal ring. This variety of hernia is called *oblique inguinal hernia.* In traversing the inguinal canal to the scrotum the protrusion will have the following coverings from within outwards: (1) peritoneum (the sac of the hernia); (2) extra-peritoneal fatty tissue; (3) infundibuliform fascia; (4) cremasteric fascia; (5) external spermatic

fascia; (6) superficial fascia; and (7) skin. If on the other hand a protrusion takes place medial to the epigastric artery either through the medial inguinal fossa or through the supravesical fossa the hernia is called *direct inguinal hernia.* This protrusion does not enter the inguinal canal through the abdominal inguinal ring and hence does not get the infundibuliform fascia as its covering. If the hernia occurs through the medial inguinal fossa the coverings of such a hernia will be the same as in the case of oblique inguinal hernia except that the infundibuliform fascia is replaced by fascia transversalis stretched. If the hernia occurs through the supravesical fossa the coverings from within outwards will be: (1) peritoneum (sac of the hernia); (2) extra-peritoneal fatty tissue; (3) fascia transversalis; (4) inguinal aponeurotic falx; (5) external spermatic fascia; (6) superficial fascia; and (7) skin.

Divide the lower flap of the peritoneum by a vertical incision from the umbilicus to the symphysis pubis and reflect the flaps on either side. The contents of the abdomen are now exposed.

Surface View of the Contents.- Without disturbing the parts the student can see the margin of the liver below the costal arch, the gall bladder (if it is not empty or collapsed), a portion of the stomach, the great omentum covering the coils of the small intestine, the bladder (behind the symphysis pubis) if distended, and the uterus if pregnant. It happens sometimes that the great omentum is short or drawn up or turned to one side. In that case the coils of the small intestine, the cæcum in the right iliac fossa and the descending colon in the left iliac fossa will also be seen.

Regions of the Abdomen.—In order to facilitate the description of the situation of the viscera, it is customary with anatomists to divide the abdominal cavity into nine

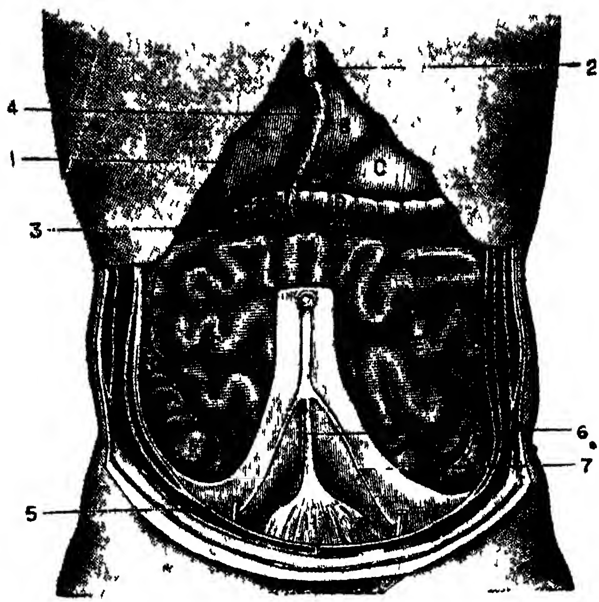


Fig. 7.—Position of the viscera as seen after the removal of the anterior abdominal wall.

A. Right lobe of the liver.
B. Left lobe of the liver.
C. Stomach.
D. Transverse colon.
E. Coils of the small intestine.
F. Cæcum.
G. Ascending colon.
H. Bladder.
I. Gall-bladder.

1. Costal arch.
2. Xiphoid process.
3. Appendices epiploicæ.
4. Falciform ligament of the liver.
5. Inferior epigastric artery.
6. Urachus.
7. Obliterated umbilical artery.

regions by four lines,—two passing vertically and two transversally. The two vertical lines are drawn from a point midway between the symphysis pubis and the anterior superior iliac spine vertically upwards. Of the two transverse lines the upper one passes through the lowest point of the tenth costal cartilage and is called the *sub-costal line* and the lower one passes through the highest

point of the iliac crests and is called the *intertubercular line*. The upper three regions are called the *right hypochondriac*, the *epigastric* (in the middle), and the *left hypochondriac*. The middle three regions are called the *right lumbar*, the *umbilical* (in the middle), and the *left lumbar*. The lower three regions are called the *right iliac*, the *hypogastric* (in the middle), and the *left iliac*. The viscera contained in these regions cannot all be seen now.

The student should now identify and study the situation and relations of the abdominal contents as revealed after the removal of the anterior abdominal wall. For the present dissection with scalpel is not necessary; the forceps or even both hands when required should be used for the purpose.

The **Stomach** is the most dilated portion of the alimentary canal. It is situated in the left hypochondriac and epigastric regions. Its shape and position vary with the amount of food or gas contained in it. When empty (the condition in which it is generally seen in the dissecting room), its walls are in contact with each other. When distended it is more less pear-shaped. Observe that its upper end or *fundus* is large and rounded. Raise the left lobe of the liver and notice the œsophagus opening into the viscus about two inches below the highest point of the organ. This opening is known as the *œsophageal* or *cardiac orifice* of the stomach. The *anterior surface* of the stomach is in relation with the liver, the diaphragm and the anterior abdominal wall. Its *posterior surface* lies upon (as will be seen afterwards) the crura of the diaphragm, the aorta, the pancreas, the left kidney and suprarenal gland, and the spleen. The upper border of the stomach is concave and is called the *lesser curvature*. It is connected with the undersurface of the liver by a duplicated fold of peritoneum, called the *lesser omentum*

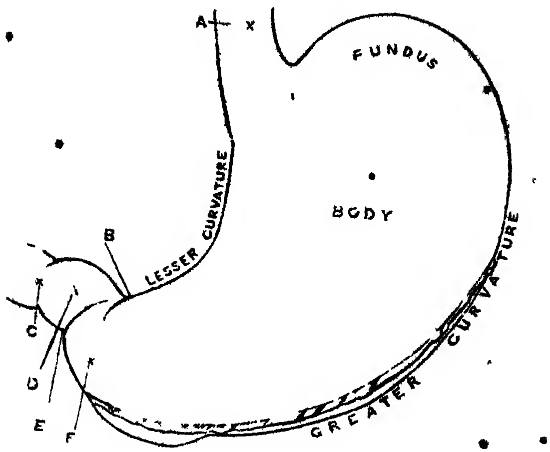


Fig. 8.—The stomach (after Buchanan).

A. Œsophagus.
B. Incisura angularis.
C. Duodeno-pyloric constriction
D. Pyloric canal.
E. Sulcus intermedius
F. Pyloric antrum.

or *gastro-hepatic ligament.* The lower border of the stomach is convex and is called the *greater curvature;* its left part is connected to the spleen by a duplicated fold of peritoneum called the *gastro-lienal ligament* and its anterior part is connected with the transverse colon by a duplicated fold of peritoneum called the *greater omentum* or *gastro-colic ligament.* The lower end of the stomach is called the *pyloric end* and presents a constriction at its termination which indicates the position of the *pyloric orifice* by which the stomach opens into the duodenum.

The **Small Intestine** begins at the pyloric constriction and is divided into three portions: the duodenum, the jejunum, and the ileum.

The Duodenum is the first part of the small intestine. It is so called on account of its length being about the breadth of twelve fingers. It begins at the pyloric cons-

triction and passes upwards and backwards to the gall bladder. From here it descends and is concealed by the transverse colon behind which it passes. Then it crosses the vertebral column from the right to the left and terminates on the left side of the body of the second lumbar vertebra. Since the greater part of it is deeply situated its relations will be studied at a later stage of the dissection.

The **Jejunum** and the **Ileum** form the coils of the small intestine. They lie in the umbilical, hypogastric, and the right and left iliac regions. To see the commencement of the jejunum the greater omentum and the transverse colon should be thrown over the costal arches and the coils of the small intestine drawn over to the right side. The upper two-fifths of the coils of the small intestine constitute the jejunum and the lower three-fifths, the ileum. There is no sharp line of demarcation between these two portions of the small intestine showing the termination of the one and the beginning of the other. The jejunum begins at the termination of the duodenum on the left side of the second lumbar vertebra in a flexure called the *duodeno-jejunal flexure*. Observe that the jejunum and the ileum are connected to the posterior abdominal wall by a broad duplicated fold of peritoneum called the *mesentery* or the *mesentery proper*. The termination of the ileum in the caecum, will be seen in the right iliac fossa by turning over the small intestine to the left side.

The **Large Intestine** begins at the termination of the ileum in the right iliac fossa and ends in the anus. It is subdivided into the caecum, the ascending colon, the transverse colon, the descending colon, the sigmoid colon, the rectum and the anal canal.

The **Caecum** is the dilated pouch at the commencement of the large intestine. It lies in the right iliac fossa

and is usually not completely covered by peritoneum. It is usually clothed by the membrane anteriorly and on the sides, its posterior aspect being bare and connected by loose areolar tissue with the fascia iliaca. In some cases (in about fourteen per cent. of the Hindus, vide Journal of Anatomy vol. LIII, parts II and III, 1919) it is completely clothed by peritoneum and connected with the iliac fossa by a loose fold of peritoneum called the *mesocæcum*. Connected with its medial and back part is a worm-like tube called the *vermiform process*. It is about three inches in length with a diameter equal to that of a goose quill. It is completely covered by peritoneum and kept in situ by a small peritoneal fold called the *mesentery of the vermiform process*. The vermiform process is usually directed upwards and medialwards but it may occupy any possible position consistent with its mobility.

The **Ascending Colon** commences in the right iliac fossa from the cæcum and passes upwards through the right lumbar region to the under surface of the liver. Here the gut bends and turns to the left forming the *right flexure of the colon* (Hepatic flexure). It is usually covered in front and at the sides by peritoneum and its posterior aspect is usually bare and rests on the fascia covering the quadratus lumborum muscle and the right kidney, being connected with them by a loose areolar tissue. In a certain percentage of cases (seventeen per cent. in Hindus, vide Journal of Anatomy vol. LIII, parts II and III, 1919) the ascending colon is completely [illegible] by peritoneum leaving a loose fold behind ca[illegible] *ascending mesocolon*.

The **Transverse Colon** extends from the right colic flexure transversely to the left and terminates below the spleen in a bend [illegible]ed the *left flexure of the colon* (Splenic flexure). In its course to the left it describes a curve with

its convexity directed downwards and forwards. It is connected with the posterior abdominal wall by a long duplicated fold of peritoneum called the *transverse mesocolon*. The greater omentum is attached to its lower part. The left colic flexure is attached to the diaphragm by a fold of peritoneum called the *phrenico-colic ligament.*

The **Descending Colon** extends from the left colic flexure downwards to the brim of the lesser pelvis. It lies in the left hypochondriac, left lumbar and left iliac regions. In its course it lies over the left kidney. It is usually covered in front and at the sides by peritoneum. But in some cases (twenty five per cent. in Hindus) it is completely invested by peritoneum which forms a loose fold behind called the *descending mesocolon.* Thus a descending mesocolon is more frequent than a mesocæcum or ascending mesocolon.

The **Sigmoid Colon** begins from the brim of the lesser pelvis and crosses the pelvic cavity between the bladder and the rectum in males or between the uterus and the rectum in females towards the right pelvic wall. Then it arches backwards to reach the middle line opposite the third piece of the sacrum where it ends in the rectum. It is entirely covered by peritoneum which forms a loose fold behind called the *sigmoid mesocolon*.

The **Rectum** begins opposite the third piece of the sacrum and terminates in the anal canal. Only its upper part [illegible] be seen now, lying behind the bladder in males and [illegible] in females. This upper portion is covered in [illegible] at the sides by peritoneum. The remaining part [illegible] rectum and the anal canal will be studied during the dissection of [illegible] pelvis.

The **Liver** occupies [illegible] right h[illegible]hondriac, the epigastric and a part of [illegible] left hy[illegible]ondriac regions. The whole [illegible] cannot [illegible] studied u[illegible] it is removed

from the abdominal cavity. Under present conditions only such parts and connections are to be studied as are possible with the organ in situ. The upper surface of the liver is in relation with the under surface of the diaphragm. To the upper and anterior surfaces is attached a triangular fold of peritoneum called the *falciform ligament* along the base of which runs a rounded cord, called the *round ligament* or *ligamentum teres*, towards the umbilicus. The under surface of the liver is in contact with the right kidney, the right flexure of the colon, the pyloric end of the stomach and the commencement of the duodenum. Its anterior sharp margin will be seen presenting two notches; one is placed opposite the attachment of the falciform ligament and the other is for the fundus of the gall-bladder opposite the cartilage of the ninth rib. The lesser omentum will be seen passing from the under surface of the liver to the lesser curvature of the stomach.

The **Spleen** cannot be seen in the normal condition with the parts undisturbed. But if the stomach be drawn to the right and the hand passed into the left hypochondriac region, the organ will be discovered lying obliquely in the abdominal cavity. It lies in the left hypochondriac and epigastric regions. It is connected with the stomach by a duplicated fold of peritoneum called the *gastro-colic ligament*, and with the left kidney by a similar fold called the *lieno-renal ligament*.

The **Kidneys and Pancreas** are deeply situated and hence their position and relations will be better studied when the superficial viscera have been removed.

The **Uterus** in a female subject will be seen lying between the bladder in front and the rectum behind. It is connected with the lateral pelvic wall by a duplicated fold of peritoneum called the *lateral ligament of the uterus* or the *broad ligament*.

The **Peritoneum** is a serous membrane which lines the inner surface of the walls of the abdominal and pelvic cavities and is reflected upon all the viscera contained in these cavities, providing partial or complete coverings to them. The portion reflected upon the viscera is termed the *visceral layer* and that which lines the inner surface of the abdominal and pelvic parietes is called the *parietal layer*. It is rather difficult to understand the reflections of the peritoneum; since unlike other serous membranes *e. g.*, the pleura or the pericardium, it invests partially or completely a large number of viscera of different shapes and sizes. In order to get an idea of the reflections of the peritoneum the student should remember that wherever it is traced it is one and the same membrane and that after it has invested the viscera and parietes it forms by itself a closed sac. The wall of the sac has been pushed from outside by some viscera to a considerable extent, but they are still outside the cavity of the sac. The fact that in the female the peritoneal cavity communicates with the uterine cavity through the uterine tube and is not thus absolutely a closed sac may for the present be disregarded by the student.

Let us follow the peritoneum in the **vertical direction.** The dissector has seen the lesser curvature of the stomach. Here two layers of peritoneum are found to meet after covering the surfaces of the stomach. These are continued in apposition to the under surface of the liver constituting the *hepato-gastric ligament.* At the porta of the liver the two layers separate,—an anterior and a posterior. The anterior layer passes forwards over the under surface of the liver, lines its anterior and superior surfaces and is then reflected upon the diaphragm and becomes continuous with the peritoneum lining the anterior abdominal wall. After lining the whole of the inner surface of the anterior abdominal wall it is reflected

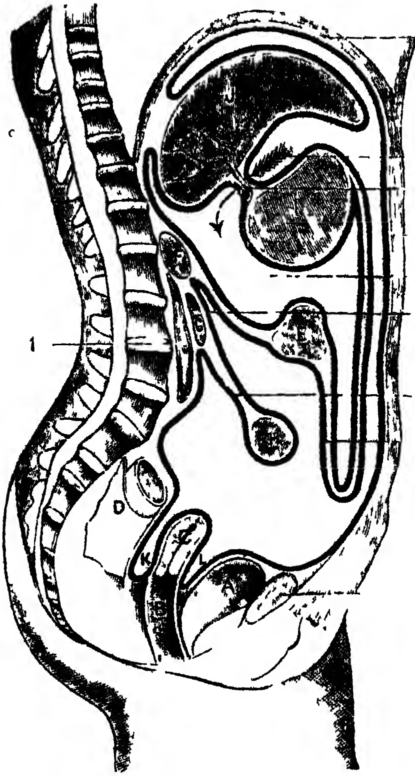


Fig. 9.- Diagram to illustrate the peritoneum as seen in a vertical section.

A. Bladder.
B. Vagina.
C. Uterus.
D. Rectum.
E. Transverse colon.
F. Pancreas.
G. Duodenum.
H. Small intestines.
I. Stomach.
J. Liver.
K. Recto-uterine excavation.
L. Vesico-uterine excavation.

1. Aorta.
2. Arrow indicating the continuation of the greater with the lesser sac
3. Hepatic artery.
4. Omental bursa.
5. Transverse mesocolon.
6. Mesentery proper.
7. Great omentum.
8. Diaphragm.
9 Anterior abdominal wall.
10. Symphysis pubis.

on to the bladder and covers it partially. From the bladder it is then reflected on the anterior surface of the rectum in the male forming a pouch between the bladder and the rectum called the *recto-vesical excavation.* In the female, it is reflected from the bladder to the anterior surface of the uterus forming a pouch, called the *vesico-uterine excavation.* Having covered the posterior surface of the uterus and the upper part of the posterior wall of the vagina it is reflected on to the anterior surface of the rectum forming a deep pouch, called the *recto-uterine excavation* (pouch of Douglas). Having observed how it covers the front and sides of the upper part of the rectum and completely invests the sigmoid colon forming a loose fold behind it, the *sigmoid mesocolon,* follow it upwards as it lines the posterior abdominal wall and covers the superior mesenteric vessels posteriorly forming the posterior layer of the mesentery. Then it encircles the small intestines and covers the superior mesenteric vessels anteriorly, forming the anterior layer of the mesentery. It then covers the inferior surface of the pancreas and at the anterior border of the gland is reflected downwards forming the inferior layer of the transverse mesocolon. It covers the posterior and inferior surfaces of the transverse colon and from its inferior surface is reflected downwards as the most posterior layer of the free fold called the greater omentum. At the free border of the greater omentum it is folded on itself forming the most anterior layer of the greater omentum. On reaching the greater curvature of the stomach it invests its anterior surface and reaches the lesser curvature to become continuous with the anterior layer of the lesser omentum, from where we started tracing. The posterior layer of the lesser omentum passes backwards from the porta of the liver, covers the caudate lobe and caudate process of the liver and is reflected on to the under surface of the

diaphragm. Traced downwards it covers the anterior surface of the pancreas and from its anterior border is prolonged as the anterior layer of the transverse mesocolon. Then it covers the anterior and inferior surfaces of the transverse colon and is continued downwards as far as the free border of the greater omentum forming the posterior boundary of the lesser sac. Then it is folded on itself and passes upwards as the posterior layer of the descending part of the greater omentum and forms the anterior boundary of the omental bursa. Then it reaches the greater curvature of the stomach, covers its posterior surface and is prolonged from the lesser curvature as the posterior layer of the lesser omentum from where we started tracing.

If Fig. 9 is looked into, it will be seen that the peritoneal cavity is divided into two sacs which communicate with each other behind the right margin of the lesser omentum through a channel called the *epiploic foramen* (foramen of Winslow). The greater sac is placed in front and the lesser sac called the *omental bursa* is placed behind it. Pass your finger behind the right free margin of the lesser omentum into the epiploic foramen and the following boundaries will be felt : *in front,* the free margin of the lesser omentum enclosing between its two layers the portal vein, the hepatic artery and the bile duct ; *behind,* the inferior vena cava covered by peritoneum ; *above,* the caudate process of the liver ; and *below,* the commencement of the duodenum and the hepatic artery before it ascends through the layers of the lesser omentum.

If the peritoneum is traced transversely (Fig. 10) at the level of the epiploic foramen the continuity of the two sacs will be seen. Beginning at the anterior abdominal wall the peritoneum will be found to cover the obliterated umbilical vein in the middle line forming the falciform ligament. Traced to the left it is reflected from the lateral

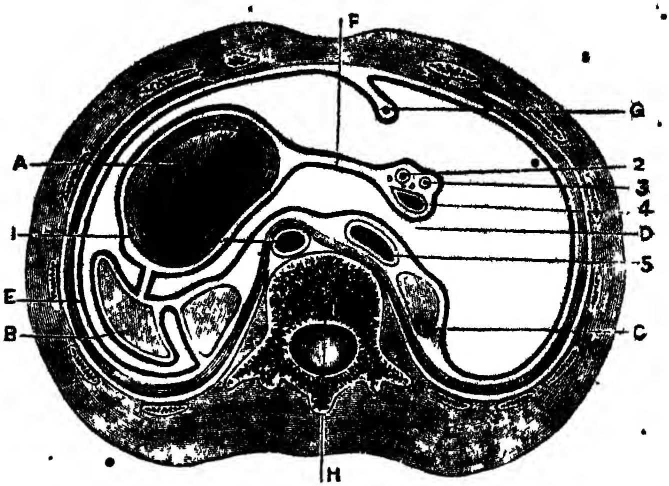


Fig. 10. –Transverse section of abdomen at the level of the epiploic foramen.

A. Stomach.
B. Spleen.
C. Right kidney.
D. Epiploic foramen.
E. Parietal peritoneum.
F. Hepato-gastric ligament.
G. Ligamentum teres.
H. Twelfth thoracic vertebra.

1. Aorta.
2. Hepatic artery.
3. Bile duct.
4. Portal vein.
5. Inferior vena cava.

wall of the abdomen on to the anterior surface of the left kidney. From here it is reflected on to the hilum of the spleen forming the posterior layer of the phrenico-lienal ligament (lieno-renal ligament). Then it covers the surface of the spleen and comes to the anterior aspect of its hilum. Thence it passes to the left part of the greater curvature of the stomach forming the anterior layer of the gastro-lienal ligament. Here it covers the antero-superior surface of the stomach and the beginning of the duodenum and is prolonged upwards from the lesser curvature of the stomach as the anterior layer of the

lesser omentum. Traced to the right the peritoneum winds round the free margin of the lesser omentum forming the anterior boundary of the epiploic foramen. Traced again to the left it forms the anterior wall of the omental bursa. Tear through the front two layers of the greater omentum below the greater curvature of the stomach and introduce the hand into the omental bursa behind the stomach. The peritoneum forming the anterior wall of the omental bursa passes to the left covering the postero-inferior surface of the stomach and passes to the hilum of the spleen as the posterior layer of the gastro-lienal ligament. Thence it passes to the medial aspect of the anterior surface of the left kidney as the anterior layer of the phrenico-lienal ligament. It then passes to the right across the posterior abdominal wall covering the aorta, the inferior vena cava, the right suprarenal gland and kidney. From here it is reflected on to the anterior abdominal wall from where we started tracing.

In the lower abdomen the arrangement of the peritoneum presents a simpler condition if traced transversely. Starting from the linea alba and proceeding to the right the membrane lines the inner surface of the anterior and lateral abdominal wall, and on the posterior wall covers the ascending colon anteriorly and at the sides. Then it passes towards the vertebral column and covers the mesenteric vessels on their right side. Encircling the small intestines it is reflected on the left side of the mesenteric vessels thus completing the mesentery. Traced further to the left it covers the front and sides of the descending colon and is then reflected on to the lateral and anterior abdominal wall back to the linea alba from where we started tracing.

In tracing the peritoneum through its many reflections the dissector has noticed certain terms have been applied

to designate its several folds. Some of these folds may now be studied in detail :—

(1) The *lesser omentum* is a duplicated fold of peritoneum which extends from the lesser curvature of the stomach and the first part of the duodenum to the porta of the liver. The portion of it between the liver and the stomach is called the *hepato-gastric ligament;* and the portion lying between the liver and the duodenum is called the *hepato-duodenal ligament.* Between the two layers of it near the right free margin will be seen the bile duct, the hepatic artery and the portal vein.

(2) The *greater omentum* is the duplicated fold of peritoneum which descends from the greater curvature of the stomach and the first part of the duodenum for a considerable distance and then ascends folding on itself to the under surface of the transverse colon where it splits to enclose it. These four layers formed by the doubling cannot be demonstrated as separate layers in the adult. To the left it is continuous with the gastro-lienal ligament.

(3) The *mesenteries* are (*a*) the mesentery proper, (*b*) the transverse mesocolon, and (*c*) the sigmoid mesocolon. The *mesentery proper* is the duplicated fold of peritoneum which connects the jejunum and ileum to the posterior abdominal wall. It is attached along a line extending from the left side of the second lumbar vertebra (the commencement of the jejunum) to the right iliac fossa (the termination of the ileum). It is narrow at its attachment to the posterior abdominal wall and broad where it encloses the small intestine. Between its two layers are contained the superior mesenteric vessels and plexus of nerves and mesenteric lymph glands. The *transverse mesocolon* is the broad transverse fold of peritoneum connecting the transverse colon to the posterior abdominal wall along the anterior border of the pancreas. The *sigmoid mesocolon* is a V-shaped fold with its apex near

the bifurcation of the left common iliac artery. Between its two layers are seen the sigmoid and superior hæmorrhoidal vessels.

Certain *peritoneal fossæ* or pouches are now to be examined. These are :—(1) The *duodenal fossæ* which are three in number. (*a*) The *inferior duodenal fossa* is present in about seventy five per cent. of subjects. It is situated opposite the third lumbar vertebra to the left of the ascending portion of the duodenum. It has its cavity looking upwards. (*b*) The *superior duodenal fossa* is present in about fifty per cent. of subjects. It is situated opposite the second lumbar vertebra to the left of the ascending part of the duodenum. Its cavity looks downwards. (*c*) The *duodeno-jejunal fossa* is present in about fifteen to twenty per cent. of subjects. It is situated below the pancreas between the aorta and left kidney and its orifice is directed downwards and to the right. (2) The *cæcal fossæ* are three in number. (*a*) The *superior ileo-cæcal fossa* is situated above the ileo-colic junction and is formed by a fold of peritoneum covering the ileo-colic artery which supplies the junction. (*b*) The *inferior ileo-cæcal fossa* is situated below the ileo-cæcal junction. It has in front the mesentery of the vermiform process. (*c*) The *retro-cæcal fossa* lies behind the cæcum and is seen by raising it. (3) The *intersigmoid fossa* is situated to the left of the sigmoid colon on the external iliac vessels. It is present in the fœtus and infancy and disappears with advance of age. (4) The *recto-vesical*, the *recto-uterine* and the *vesico-uterine fossæ* or excavations have been already referred to.

Certain other peritoneal folds or ligaments connect the viscera to the abdominal wall. These will be examined when the viscera are studied. Raise the greater omentum and transverse colon and throw them over the thoracic wall. Draw the small intestines downwards and to the

left. The right layer of the mesentery is then to be removed. This removal should be commenced at the jejunum and continued till the end of the ileum is reached. Remove also the inferior layer of the transverse mesocolon as also the peritoneum directed towards the cæcum and the ascending colon over the posterior abdominal wall. The superior mesenteric artery and its branches will now be seen.

The **Superior Mesenteric Artery** supplies the whole of the small intestine, the cæcum, the ascending colon and the right half of the transverse colon. It arises from the abdominal aorta behind the pancreas. Then it crosses the lower part of the head of the pancreas and the third part of the duodenum and descends between the two layers of the mesentery proper till it reaches the right iliac fossa. Here it anastomoses with one of its branches forming an arch the concavity of which is directed towards the right side. It is surrounded by the superior mesenteric plexus of nerves.

Branches.—(1) The *inferior pancreatico-duodenal* is the first branch of the superior mesenteric. Sometimes it arises from its first jejunal branch. It passes to the right between the head of the pancreas and duodenum, supplies both, and anastomoses with the superior pancreatico-duodenal artery. (2) The *jejunal and ileal branches* (vasa intestini tenuis) are twelve to fifteen in number. They arise from the convexity of the arch. Each of them divides into two branches which by their union with the contiguous branches form a series of arches. From the convexities of these arches small branches are given off which divide and anastomose in a similar manner forming a second series of arches. Thus a third, a fourth or even a fifth series of arches are formed. From the convexity of the last arches small branches are given off which encircle the intestines and supply them. (3) The *ileo-colic*

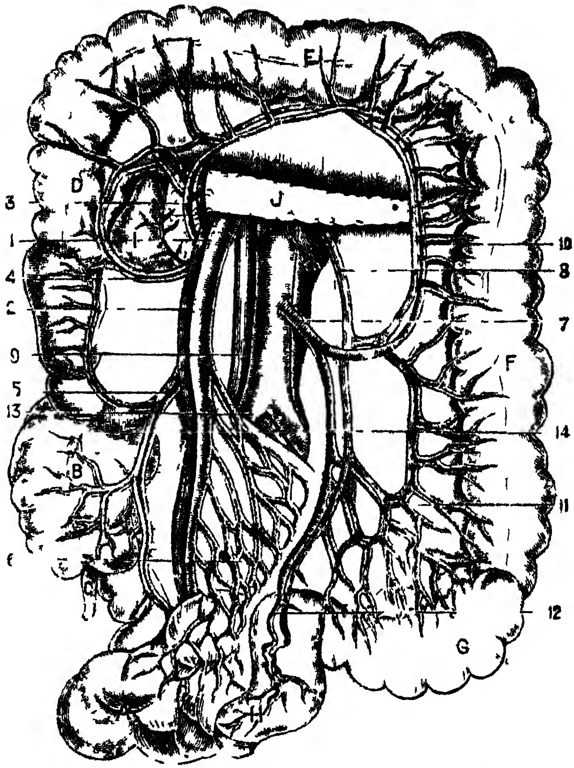


Fig. 11.–Diagram of the superior and inferior mesenteric arteries.

A. Small intestines.
B. Cæcum.
C. Vermiform process.
D. Ascending colon.
E. Transverse colon.
F. Descending colon.
G. Sigmoid colon.
H. Rectum.
I. Duodenum.
J. Pancreas.

1. Superior mesenteric artery.
2. Superior mesenteric vein.
3. Middle colic artery.
4. Right colic artery.
5. Ileo-colic artery.
6. Jejunal and ileal branches.
7. Inferior mesenteric artery.
8. Inferior mesenteric vein.
9. Inferior vena cava.
10. Left colic artery.
11. Sigmoid artery.
12. Superior hæmorrhoidal artery.
13. Right common iliac artery.
14. Left common iliac vein.

artery arises from the concavity of the superior mesenteric artery. It passes downwards and to the right behind the peritoneum and divides into two branches, a superior and an inferior. The superior branch ascends and anastomoses with the right colic artery. The inferior branch gives off the following branches:— (*a*) colic branches which pass upwards on the ascending colon, (*b*) anterior and posterior cæcal branches which supply the front and back of the cæcum, (*c*) appendicular artery which descends behind the last part of the ileum and passes along the mesentery of the vermiform process to supply it, (*d*) ileal branch which passes to the left along the ileum and communicates with the termination of the superior mesenteric artery. (4) The *right colic artery* or colica dextra arises from the concavity of the superior mesenteric artery above the ileo-colic or sometimes in common with it. It passes towards the ascending colon and divides into an ascending and a descending branch. The former anastomoses with the middle colic and the latter with the superior branch of the ileo-colic. From the anastomotic arch twigs pass to the ascending colon. (5) The *middle colic artery* or colica media arises from the superior mesenteric artery just below the pancreas. It passes forwards between the two layers of the transverse mesocolon and divides into a right and a left branch. The right branch anastomoses with the ascending branch of the right colic artery and the left branch with the left colic artery. From the anastomotic arch twigs pass to supply the transverse colon.

The **Superior Mesenteric Vein** lies to the right side of its companion artery. It receives tributaries corresponding to the branches of the artery, and behind the pancreas unites with the splenic vein to form the portal vein.

The **Superior Mesenteric Plexus** consists of nerve

filaments derived from the plexus of the sympathetic around the cœliac artery. These nerve filaments surround the superior mesenteric artery and accompany its branches to the intestines.

Observe the numerous lymphatic glands each about the size of a pea lying between the two layers of the mesentery. These are called the *mesenteric lymph glands.* Radiating from these glands are minute, white, thread-like structures. These are the lacteal vessels.

Turn over the coils of the small intestine to the right side. Remove the peritoneum that lies over the lower part of the aorta and the space between the left side of the vertebral column and the descending colon. The inferior mesenteric artery will now be seen.

The **Inferior Mesenteric Artery** arises from the abdominal aorta about an inch and a half above its bifurcation. It passes downwards and to the left, crosses the left common iliac artery and is continued as the superior hæmorrhoidal artery into the rectum. *Branches.*—(1) The *colica sinistra* or the left colic artery passes to the left and divides into an ascending and a descending branch. The former ascends to anastomose with the left branch of the middle colic artery. The latter anastomoses with the highest sigmoid artery. From the anastomotic arch twigs are supplied to the left part of the transverse colon and the descending colon. (2) The *sigmoid arteries* are two or three in number. They pass downwards and to the left. The highest one anastomoses with the descending branch of the left colic and the lowest one with the superior hæmorrhoidal artery. They supply the lower part of the descending colon and the sigmoid colon. (3) The *superior hæmorrhoidal artery* supplies the rectum and will be traced during the dissection of the lesser pelvis.

The **Inferior Mesenteric Vein** receives tributaries

corresponding to the branches of the artery. It ascends along the left side of the artery and opens into the splenic vein behind the pancreas.

The **Inferior Mesenteric Plexus** consists of nerve filaments prolonged from the aortic plexus of the sympathetic. It surrounds the inferior mesenteric artery and is distributed with its branches.

Remove the intestines with the exception of the duodenum and the rectum from the abdominal cavity. Put two ligatures, about half an inch apart, on the upper end of the jejunum and cut between the two. Similarly apply two ligatures on the lower end of the sigmoid colon and cut the gut between the two. Where the mesentery is long cut close to the gut. The whole of the intestines should then be properly cleaned out by allowing a stream of water from the tap to run freely through the lumen of the gut after removing the ligatures. Keep the last three inches of the ileum and the cæcum intact. From the remaining portion of the lower end of the ileum take about four inches and a similar portion from the upper part of the jejunum. Slit these open with scissors along the line of attachment of the mesentery. Next lay open a portion of the colon, about four inches long in the same manner. Put these specimens in a shallow dish containing water.

Mucous Membrane of the Intestines.—The dissector will now see the differences presented in the mucous membrane in the different portions of the gut. In the specimen of the jejunum the mucous membrane is thrown into transverse folds called the *plicæ circulares* (Valvulæ conniventes). These folds are not obliterated if the gut is distended or stretched and are permanent folds. Most of these folds extend transversely across the lumen for about one-half or two-thirds of the circumference. Some form complete circles and a few will be seen passing two or three turns in the form of a spiral round the lumen.

In the upper part of the jejunum (specimen under examination) they are very closely set and large. If a portion of the jejunum *l*ower down is opened they will be seen to diminish in number and size. Lower down, in the ileum they become fewer and less prominent and in the lower fourth of the ileum they are absent altogether. The function of these circular folds is (1) to retard the progress of food along the intestine and (2) to afford a greater surface for absorption.

If the specimen from the lower end of the ileum is examined the dissector may see one or more oval nodules of lymph follicles. These are called aggregated lymph nodules (Peyer's patches). If they are not found in the specimen under examination another bit from the lower part of the iluem may be opened and looked for. They are either circular or oval and one to four inches in length. Their total number varies from twenty to thirty. They are placed lengthwise with their long axis parallel to the length of the lumen and situated opposite the attachment of the mesentery. They are largest and most numerous in the ileum and become fewer and smaller in the jejunum. They are most developed in the young, become indistinct in middle age and sometimes disappear altogether in old people.

Solitary lymph glands are seen scattered throughout the entire length of the intestinal canal but they are most numerous in the lower part of the ileum. They are small rounded bodies projecting silghtly from the surface of the mucous membrane.

If the portion of the gut from the upper part of the jejunum as it floats in the dish be examined with a pocket lens, minute processes called *villi* projecting from the surface of the mucous membrane will be seen. They exist upon the surface of the circular folds and in the spaces between them as well. They are found in large

numbers and most distinctly developed in the upper part of the small intestine. They diminish in number and size in the ileum.

The mucous membrane of the large intestine presents a striking contrast to that of the small gut. In the portion of the colon which has been laid open it will be seen that there are neither circular folds nor villi, nor aggregated lymph nodules; but solitary lymph nodules are found in large numbers.

Structure of the Intestines.—Four coats enter into the formation of the walls of the large and of the small gut. These are (1) serous, (2) muscular, (3) submucous and (4) mucous.

The *serous coat* is derived from the peritoneum. It completely invests the upper portion of the duodenum and also the jejunum and the ileum except at the line of attachment of the mesentery. In the large intestine the peritoneum presents stalked pouches containing fat and hanging freely. These are called *appendices epiploicæ* and are characteristic of the large intestine. They are not found in the rectum.

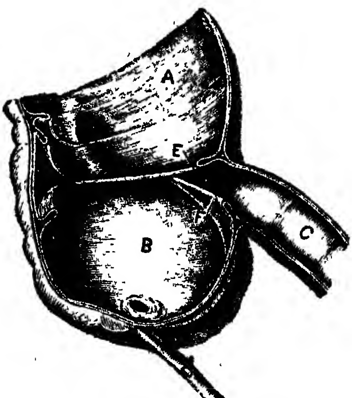
The *muscular coat* will be exposed on removing the serous covering. It consists of fibres arranged in two layers viz., an external layer of longitudinal fibres and an internal layer of circular fibres. In the cæcum and colon the external layer of longitudinal fibres instead of being uniformly distributed over the gut is collected into three longitudinal bands called *tæniæ coli*; the first the posterior called the *tænia mesocolica*, placed along the attached border of the intestine; the second, the anterior or *tænia omentalis*, the largest, and situated in front of the ascending, the descending, and the sigmoid colon and along the attachment of the greater omentum in the transverse colon; the third, called the *tænia libera*, placed along the medial side of the ascending and descending colon and

on the under surface of the transverse colon. These bands if traced in the cæcum will be found to converge to the vermiform process. They are shorter than the length of the canal and hence if they are divided, the canal lengthens. The sacculation of the large intestine is due to the presence of these longitudinal bands. The circular muscle fibres form a thin layer evenly distributed.

The *submucous coat* consists of loose areolar tissue binding the muscular layer to the mucous layer.

The *mucous coat* has been already examined.

The student should next study the ileo-cæcal orifice and the valve guarding it. Take the cæcum with the last three inches of the ileum attached to it and ligature the gut at one end. Inflate this portion of the gut and tie the other end and let it be hung up to dry. When the specimen is dry the lateral wall of the distended cæcum should be removed.



A. Ascending colon.

B. Cæcum.

C. Ileum.

D. Vermiform process.

E. Upper fold of colic valve.

F. Lower fold of colic valve.

Fig. 12.—Diagram of the colic valve (after Wilson).

The **Colic Valve** (Ileo-cæcal valve) guards the ileo-cæcal orifice. It consists of two semilunar shaped seg-

ments, an upper and a lower. They are formed by a prolongation of the mucous membrane, submucous tissue and circular muscle fibres. The upper segment is horizontal, and its ends coalesce with those of the lower one. The lower one is larger and oblique. Two ridges are continued on the inner surface of the wall of the cæcum from where the ends of the two segments coalesce. These are called the *frenula* of the valve.

The cœliac artery and its branches should now be dissected. Draw the stomach downwards. Raise the liver and fix it to the ribs by chain hooks. Remove the anterior layer of the lesser omentum. Clean the vessels lying along the lesser curvature of the stomach and the structures lying between the two layers of the lesser omentum near its right free margin. These are (1) the hepatic artery to the left, (2) the bile duct to the right and (3) the portal vein between and behind the two. When both layers of the lesser omentum have been removed, the peritoneum which forms the posterior wall of the omental bursa should be peeled off commencing below from the upper border of the pancreas. Clear the cœliac artery and note that it is surrounded by a plexus of nerves, called the cœliac plexus.

The **Cœliac Artery** (Cœliac axis) is a short thick trunk, about half an inch in length. It arises from the front of the abdominal aorta just below the aortic hiatus and above the upper border of the pancreas. It passes horizontally forwards and divides into three branches viz., the left gastric, the hepatic, and the lienal or splenic.

The **Left Gastric Artery** (Gastric or coronary artery) passes upwards and to the left behind the omental bursa to the right side of the cardiac orifice of the stomach. Thence it changes its direction and passes along the lesser curvature of the stomach to anastomose with the right gastric branch of the hepatic. Its branches are :—(1) *œsophageal*, which

are two or three in number and ascend through the œsophageal opening of the diaphragm to anastomose with the œsophageal branches of the thoracic aorta ; (2) *cardiac*, which are distributed to the cardiac end of the stomach and anastomose with the short gastric branches of the lienal artery ; (3) *gastric*, which arise at the lesser curvature of the stomach and supply both surfaces of the viscus.

The vein accompanying the left gastric artery, called the *coronary vein*, passes along the lesser curvature of the stomach. Reaching the cœliac artery it passes to the right to open into theportal vein.

The **Hepatic Artery** is intermediate in size between the left gastric and the lienal. It passes forwards and to the right along the upper border of the pancreas to the pylorus and forms the lower boundary of the epiploic foramen. Then it ascends between the two layers of the lesser omentum forming the anterior boundary of the same foramen. Here it lies to the left of the bile duct. Near the porta of the liver it divides into two terminal branches, the right and left hepatic arteries. It is accompanied by a plexus of nerve fibres prolonged from the cœliac plexus. The branches of the hepatic artery are :— (1) The *right gastric* (pyloric) which arises near the pylorus and passes to the left along the lesser curvature of the stomach between the layers of the lesser omentum. It anastomoses with the left gastric artery and gives branches to both surfaces of the stomach. Its companion vein opens into the portal vein. (2) The *gastro-duodenal artery* which descends behind the first part of the duodenum and at its lower border divides into the *right gastro-epiploic* and the *superior pancreatico-duodenal* branches. The former runs from the right to the left along the greater curvature of the stomach and anastomoses with the left gastro-epiploic branch of the lienal artery. It gives branches to both surfaces of the stomach above and to the greater

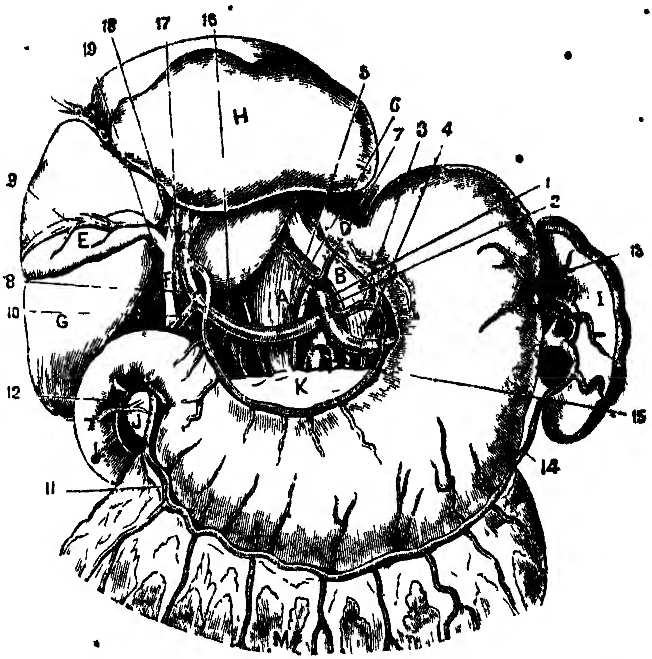


Fig. 13.—The cœliac artery and its branches (after Henle).

A. Right crus of diaphragm.
B. Left crus of diaphragm.
C. Round ligament of liver
D. Œsophagus.
E. Gall-bladder.
F. Bile duct.
G. Right lobe of liver.
H. Left lobe of liver.
I. Spleen.
J. Head of pancreas.
K. Body of pancreas.
L. Duodenum.
M. Great omentum.

1. Abdominal aorta.
2. Cœliac artery.
3. Left gastric artery.
4. Splenic artery.
5. Hepatic artery.
6. Right inferior phrenic artery.
7. Left inferior phrenic artery.
8. Right gastric artery.
9. Cystic artery.
10 Gastro-duodenal artery.
11. Gastro-epiploica dextra.
12. Pancreatico-duodenalis superior.
13. Short gastric branch of splenic artery.
14. Gastro-epiploica sinistra.
15. Superior mesenteric artery.
16 Inferior vena cava.
17. Portal vein.
18. Common hepatic duct.
19. Cystic duct.

omentum below. The superior pancreatico-duodenal branch descends between the head of the pancreas and the duodenum, supplies both these organs and anastomoses with the inferior pancreatico-duodenal branch of the superior mesenteric artery. The companion veins of these two arteries open into the superior mesenteric vein. (3) The *right hepatic artery* is one of the terminal branches and supplies the right lobe of the liver. It gives off the *cystic branch* which supplies the gall—bladder. The cystic vein opens into the portal vein. (4) The *left hepatic artery* supplies the left lobe of the liver.

The Lienal Artery (Splenic artery) is the largest of the three branches of the cœliac artery. It passes to the left along the superior border of the pancreas, crosses the upper end of the left kidney and divides into several branches which enter the hilum of the spleen. It is surrounded by a plexus of nerve filaments derived from the cœliac plexus. The *splenic vein* lies on a lower level behind the pancreas and joins the superior mesenteric vein to form the portal vein. The branches of the lienal artery are :—(1) The *pancreatic branches* which arise at intervals along the superior border of the pancreas and enter the gland. One of the branches is larger than the others and arises near the tail of the pancreas. This is called the *pancreatica magna branch*. It passes from the left to the right in the substance of the pancreas. (2) The *short gastric branches* (vasa brevia), five to seven in number, arise from the lienal artery or from its terminal branches. They pass to the right between the two layers of the gastro-lienal ligament and supply the cardiac end of the stomach, anastomosing with the branches of the left gastric and the left gastro-epiploic artery. (3) The *left gastro-epiploic artery* is directed from left to right along the greater curvature of the stomach and anastomoses with the right gastro-epiploic artery. It supplies both

surfaces of the stomach above and the greater omentum below. (4) The *terminal branches* of the splenic* artery enter the hilum of the spleen.

The **Splenic Vein** receives tributaries corresponding to the branches of the artery. In addition it receives the inferior mesenteric vein. It passes from left to right along the upper part of the posterior surface of the pancreas and behind the neck of the gland joins the superior mesenteric vein to form the portal vein.

The **Portal Vein** is formed behind the neck of the pancreas and in front of the inferior vena cava by the junction of the superior mesenteric and the splenic veins. It is about three inches in length and passes upwards behind the first part of the duodenum and then between the two layers of the lesser omentum. Here it lies behind and between the bile duct and the hepatic artery and forms the anterior boundary of the epiploic foramen. On reaching the right end of the porta hepatis it divides into a right branch and a left branch. The right branch receives the cystic vein and ramifies in the right lobe of the liver. The left branch crosses the left sagittal fossa of the liver and here it is joined by the ligamentum teres in front and by the ligamentum venosum behind. Some minute para-umbilical veins also open into it in front. Then it ramifies in the left lobe of the liver. The tributaries of the portal vein are (1) splenic vein, (2) superior mesenteric vein, (3) coronary vein, (4) right gastric vein, (5) cystic vein, (6) para-umbilical veins.

The student should next study the connections of the duodenum and in doing this he should inflate both it and the stomach.

The **Duodenum**, from its commencement at the pyloric end of the stomach to its termination at the duodeno-jejunal flexure, describes a curve resembling somewhat the shape of a horse-shoe. The concavity of the curve

embraces the head of the pancreas. It is divisible into four portions viz., (1) superior or first portion, (2) descending or second portion, (3) horizontal or third portion, and (4) ascending or fourth portion.

The *superior portion* is about two inches long. It passes upwards and backwards to the neck of the gall-bladder. Its first half is entirely covered by peritoneum. Its terminal half is only covered by peritoneum in front and superiorly. *Above* it are the under surface of the liver and gall-bladder. *Below* it lies the pancreas (head and neck). *Behind* it are the portal vein, the bile-duct and the gastroduodenal artery.

The *descending portion* is three to four inches long. It descends from the neck of the gall-bladder along the right side of the vertebral column to the right side of the third lumbar vertebra, where it terminates in the horizontal portion. *Anteriorly* it is covered by peritoneum except over its middle part where it is connected with the transverse colon by loose areolar tissue. *Posteriorly* it lies on the kidney, renal vessels and the inferior vena cava. *Medially* are found the head of the pancreas, the bile-duct and the pancreatico-duodenal arteries. *Laterally* is the right flexure of the colon. The pancreatic duct and the bile-duct open into this part of the duodenum at about its middle, piercing its wall at the medial and back part.

The *horizontal portion* is about three inches long. It begins on the right side of the third lumbar vertebra at its lower part and crosses to the left horizontally with a slight inclination upwards. It terminates in front of the abdominal aorta. It is covered by peritoneum in front only. *In front* are the superior mesenteric vessels; behind it are the aorta, the inferior vena cava and the crura of the diaphragm. *Above* it are the superior mesenteric vessels and the pancreas.

The *ascending portion* is about one inch long. It ascends along the left side of the aorta to the level of the upper border of the second lumbar vertebra. Then it turns forwards to terminate in the jejunum forming the *duodeno-jejunal flexure.* It is covered in front and on its left side by peritoneum. On removing the superficial layer of the peritoneal fold holding the duodeno-jejunal flexure, a fibro-muscular bundle will be seen streching from the left crus of the diaphragm to the end of the duodenum. This is called the *musculus suspensorius duodeni.*

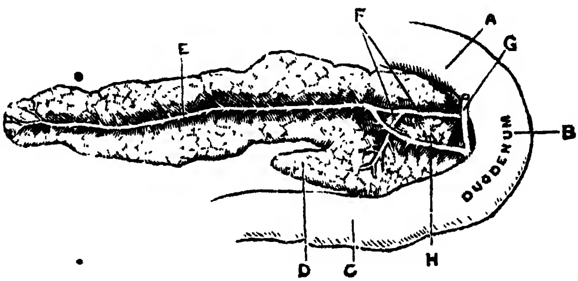


Fig. 14.—The pancreas and its ducts (posterior view). (After Buchanan).

A. First part of duodenum.
B. Second part of duodenum.
C. Third part of duodenum.
D. Uncinate process.
E. Pancreatic duct.
F. Accessory pancreatic duct.
G. Bile duct.
H. Pancreatic duct.

The **Pancreas** extends transversely in the epigastric and left hypochondriac regions of the abdominal cavity. It presents for examination a head, a neck, a body and a tail. The *head* is flattened and is embraced by the concavity of the duodenum. It lies upon the aorta, the inferior vena cava, and the bile duct. Inferiorly the head is prolonged to the left as a hook-like process called the *uncinate process* which is crossed by the superior mesenteric vessels. The *neck* is the constricted portion which

connects the head to the body and begins from the anterior surface of the upper part of the head. *Above* the neck at its right end is a groove for the gastro-duodenal artery; *below* it the superior mesenteric vessels emerge; and *behind* it is the commencement of the portal vein. The *body* has three surfaces and three borders. The *anterior surface* lies in contact with the postero-inferior surface of the stomach, separated from it by the omental bursa. Projecting upwards from the right side of this surface is an eminence called the *tuber omentale*. The *posterior* surface is in relation with the aorta, the origin of the superior mesenteric artery, the left kidney and supra-renal gland, and the splenic vein. The *inferior surface* is covered by peritoneum and rests on the duodeno-jejunal flexure, and the left flexure of the colon. The *superior border* is in relation with the hepatic artery on the right side, and the splenic artery on the left side. The *anterior border* gives attachment to the transverse mesocolon, which splits into an ascending and a descending layer along this border. The *posterior border* lies above the horizontal part of the duodenum. The *tail* of the pancreas lies in front of the left kidney and ends at the lower part of the gastric surface of the spleen.

The *pancreatic ducts* are two in number. The *main pancreatic duct* (duct of Wirsung) begins at the tail and proceeds towards the head. Divide the gland horizontally nearer the lower than the upper border and see the white duct embedded in the substance of the gland. On reaching the head of the gland it passes downwards, backwards and to the right. While coming out of the head of the pancreas, it is accompanied by the bile-duct. Both pierce the wall of the duodenum, unite and form a dilatation called the *ampulla of Vater*, which finally opens into the duodenum at the summit of an elevation called the *duodenal papilla* by a minute orifice. The *accessory pan-*

creatic duct (duct of Santorini) begins in the lower part of the head and passes upwards and gives off a branch which joins the main duct. Reaching the upper part of the head it opens into the second part of the duodenum usually by a separate opening about three-fourths of an inch above the opening of the main duct.

Bile Ducts.—Leaving the porta hepatis are two ducts. one coming from the right lobe called the *right hepatic duct*, and the other coming from the left lobe called the *left hepatic duct*. These two unite to form one duct called the *common hepatic duct*, which descends for nearly about an inch and is joined by the *cystic duct* from the gall-bladder to form the *bile-duct* or *ductus choledochus* (common bile duct). The bile duct descends between the two layers of the lesser omentum forming the anterior boundary of the epiploic foramen. Then it passes behind the first part of the duodenum to the interval between the head of the pancreas and the second part of the duodenum. Here it pierces the wall of the duodenum obliquely and is joined by the main duct of the pancreas. The united ducts terminate in a dilatation called the ampulla of Vater which opens by a narrow opening into the summit of the duodenal papilla.

Vagus Nerves.—These should now be traced. They enter the abdomen through the œsophageal opening of the diaphragm. Trace the left vagus nerve from the anterior aspect of the œsophagus. It will be found to supply the anterior surface of the stomach and to send filaments to the hepatic plexus between the two layers of the lesser omentum. The right vagus nerve will be found to lie behind the œsophagus and to distribute branches to the posterior surface of the stomach. It sends filaments to the sympathetic plexus around the cœliac artery.

The stomach, the duodenum, the pancreas, the liver

and the spleen should now be removed from the abdominal cavity. Divide the vessels and peritoneal folds which hold these organs in situ. In removing the liver first note the ligamentum teres which extends from the umbilicus along the free margin of the falciform ligament to the liver. Next examine the *falciform ligament.* It is a sickle-shaped fold of peritoneum having its anterior border attached to the diaphragm and the anterior abdominal wall. Its posterior border is attached to the anterior and superior surfaces of the liver. Its apex is directed upwards and backwards. Its base is free and encloses the ligamentum teres. Divide the ligamentum teres and the falciform ligament. Pass your hand along the upper surface of the liver till it meets with resistance. Here the peritoneum is reflected from the upper surface of the liver on to the diaphragm. The right extremity of this reflection forms the superior layer of the right triangular ligament of the liver. The central part of the reflection forms the superior layer of the coronary ligament and the left extremity forms the superior layer of the left triangular ligament of the liver. Then cut through this layer of peritoneum and draw the liver downwards. Notice the inferior vena cava emerging from the liver and piercing the central tendon of the diaphragm. Divide this vessel. The inferior layer of the right triangular, coronary and left triangular ligaments is now seen. It is formed by the reflection of peritoneum from the lower part of the posterior surface of the liver to the diaphragm. Divide this layer of peritoneum. Next divide the inferior vena cava again for the second time as it enters the liver from below. Divide the bile duct, portal vein and hepatic artery. The liver is now free from all connections, and note that as it is removed a portion of the inferior vena cava is taken away with it.

The **Liver** is the largest gland in the human body.

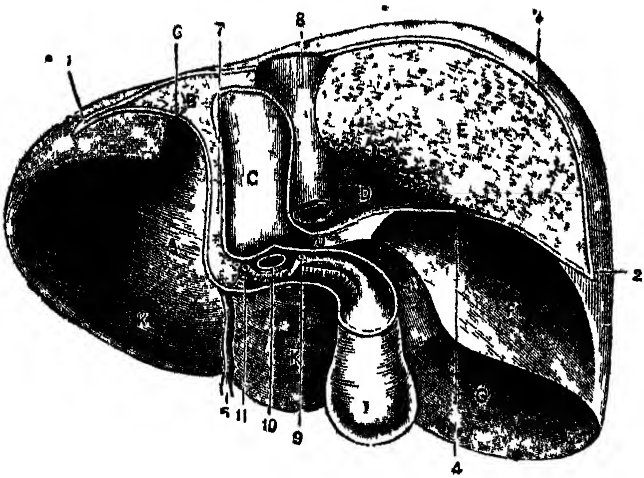
It measures transversely from 8 to 10 inches, antero-posteriorly about six inches and its greatest thickness is about six inches. It weighs about 3 to 4 lbs.

Surfaces.—(1) The *superior surface* is convex and is in relation with the under surface of the diaphragm. In the centre is a shallow depression called the *impressio cardiaca* corresponding to the position of the pericardium and heart on the diaphragm. The attachment of the falciform ligament subdivides this surface into a large right lobe and a small left lobe. It is not sharply demarcated from other surfaces. In well hardened specimens slightly rounded elevations are seen at the boundary lines. It is covered by peritoneum except at the line of attachment of the falciform ligament.

(2) The *anterior surface* is triangular and is in contact with the diaphragm and anterior abdoninal wall. It is subdivided by the falciform ligament into a large right lobe and a small left lobe.

(3) The *right lateral surface* is convex. It is separated from the anterior, superior, and posterior surfaces by indistinct borders.

(4) The *inferior surface* is concave and is directed downwards and backwards. It is in relation with the stomach, the duodenum, the right colic flexure and the right kidney. It is subdivided into a right and a left lobe by the umbilical fissure containing the ligamentum teres. The inferior surface of the left lobe presents to the left and behind the *gastric impression* for the anterior surface of the stomach. To its right is a rounded eminence called the *tuber omentale*. The inferior surface of the right lobe is subdivided into two portions by the cystic fossa which lodges the gall-bladder. The portion of the liver which lies to the left of the cystic fossa, between it and the umbilical fissure, is the *quadrate lobe*, which is limited in front by the anterior border of the organ and behind by the porta



Fig, 15.—Lower and posterior surfaces of the liver (after Wilson).

A. Tuber omentale of the left lobe.
B. Surface of liver uncovered by peritoneum.
C. Caudate lobe.
D. Impression for suprarenal gland.
E. "Bare area" of liver.
F. Renal impression.
G. Colic impression.
H. Duodenal impression.
I. Gall-bladder.
J. Caudate process.
K. Gastric impression on left and quadrate lobes

1. Cut edge of left triangular ligament.
2. Cut edge of right triangular ligament.
3. Cut edge of upper layer of coronary ligament
4. Cut edge of lower layer of coronary ligament.
5. Ligamentum teres.
6. Œsophageal notch.
7. Fissure for ductus venosus.
8. Vena cava inferior.
9. Bile duct
10. Portal vein.
11. Hepatic artery.

hepatis. The *porta hepatis* (transverse fissure) extends from the back part of the umbilical fissure towards the right to the back part of the cystic fossa. Through it the portal vein, the hepatic ducts and the hepatic artery pass. Behind the porta hepatis is the *caudate lobe*, the lower end of which is seen on the inferior surface. It is bounded on the right side by the fossa for inferior vena cava and

on the left side by the fossa for ductus venosus. The caudate lobe presents on its right side an elongated elevation by which it is connected with the remaining part of the inferior surface of the right lobe. This is called the *caudate process.* The left side of the caudate lobe presents a projection called the *papillary process.* The inferior surface of the right lobe to the right side of the cystic fossa presents three impressions :—(*a*) the *colic impression* in front for the right flexure of the colon, (*b*) the *renal impression* behind for the right kidney, and (*c*) the *duodenal impression* which lies between the renal impression and the neck of the gall-bladder, and is produced by the second portion of the duodenum.

(5) The *posterior surface* is somewhat rounded. It is broader on the right lobe than on the left, where it is reduced to a border. Commencing from the left the student will see (i) the *groove for the œsophagus.* (ii) The *venosal fissure* which lies to the right of the œsophageal groove and to the left of the caudate lobe. Inferiorly it meets the umbilical fissure and superiorly the fossa for inferior vena cava. It lodges the remains of the ductus venosus. (iii) The *caudate lobe* which lies vertically. Its lower end projects into the inferior surface. It is bounded on the left by the fossa for the ductus venosus, on the right by the fossa for the inferior vena cava and below by the porta hepatis. (iv) The *caval fossa* which lies vertically to the right of the caudate lobe. It is a deep fossa and lodges the inferior vena cava. It is sometimes bridged over by liver tissue called *pons hepatis.* (v) The "bare area" which lies to the right of the caval fossa and is destitute of peritoneum. It lies between the two layers of the coronary ligament and is attached to the diaphragm by areolar tissue. (vi) Towards the left end of the "bare area" near the caval fossa is a triangular impression called the *suprarenal impression* for the right suprarenal gland.

The **Gall-Bladder** is a pear-shaped bag, situated on the under surface of the liver in the cystic fossa extending from the anterior border of the liver to the right end of the porta hepatis. It presents for examination a fundus, a body and a neck. The *fundus* is the dilated anterior end which projects beyond the anterior border of the liver. It is entirely covered by peritoneum. The *body* has its upper surface attached to the cystic fossa by areolar tissue; its under surface is covered by peritoneum and is in relation with the duodenum and the transverse colon. The *neck* is the constricted portion which joins the cystic duct. This duct is about an inch and a half long and passes downwards, backwards and to the left to join the common hepatic duct forming the bile duct.

Structure of the gall-bladder and cystic duct.—Open the gall-bladder and the cystic duct. Note that the mucous membrane of the neck of the gall-bladder and the cystic duct is thrown into folds running in a spiral manner around the lumen. In the gall-bladder the mucous membrane is thrown into ridges with intervening depressions. Muscular and fibrous tissue form the framework of the sac. The serous or peritoneal covering has been already referred to.

The structures at the porta hepatis should now be traced into the substance of the liver for a little distance. Note that the ramifications of the portal vein, the hepatic artery and the hepatic duct accompany each other and are bound together by a fibrous sheath called *Glisson's capsule*. The channel in the liver substance containing a branch of the portal vein, a branch of the hepatic artery, a branch of the hepatic duct and lymphatic vessels all bound together by Glisson's capsule is called a *portal canal*. Cut a slice of the liver and examine its surface. The dissector will identify the portal canal by the presence of white strands of fibrous tissue (Glisson's capsule) en-

closing the cut ends of a branch of portal vein, of hepatic artery, and of hepatic duct. On this section other cut channels with gaping mouths will be seen. These are the cut ends of the hepatic veins. They are solitary and not accompanied by any other vessel. These hepatic veins are embedded in the substance of the liver and pass towards the fossa for the inferior vena cava. Open the portion of the inferior vena cava lying in the caval fossa and note the terminations of the hepatic veins in it. It should be understood that the hepatic veins are altogether embedded in the liver substance and that throughout their entire course, from their origin in the intralobular veins to their terminations into the inferior vena cava as it lies in the fossa of that organ, the hepatic veins have no course whatsoever outside the gland.

The **Lien** (Spleen) lies in the left hypochondriac and epigastric regions. It is of a dark purple colour. It measures five inches in length, three inches in breadth and one inch and a half in thickness. Its connection with the stomach by the gastro-lienal ligament and with the kidney by the phrenico-lienal ligament has been already noted. It presents for examination four borders and four surfaces. The borders are: (1) The *anterior border* which is thin and usually notched. (2) The *posterior border* which is rounded and thick and lies between the diaphragm and the left kidney. (3) The *inferior border* which connects the lower ends of the anterior and posterior borders. (4) The *intermediate border* which begins from the upper end of the spleen and bifurcates below to enclose a triangular surface with the inferior border.

The surfaces are: (1) The *diaphragmatic surface* which is convex and lies against the diaphragm opposite the ninth, tenth and eleventh ribs. (2) The *gastric surface* which is deeply concave and lies between the anterior and

intermediate borders. The fundus of the stomach lies against this surface. A little in front of the intermediate border is a longitudinal fissure called the *hilum* of the spleen through which the lienal vessels and nerves pass. In front of the lower end of the intermediate border is an impression called the *pancreatic impression* against which the tail of the pancreas lies. (3) The *renal surface* lies between the posterior and intermediate borders. It is concave and lies against the anterior surface of the left kidney. (4) The *colic surface* is triangular. It lies between the two bifurcated limbs of the intermediate border and the inferior border. This surface lies in contact with the left colic flexure. The *upper end* of the spleen is rounded and directed towards the vertebral column and the *lower end* is held by the phrenico-colic ligament.

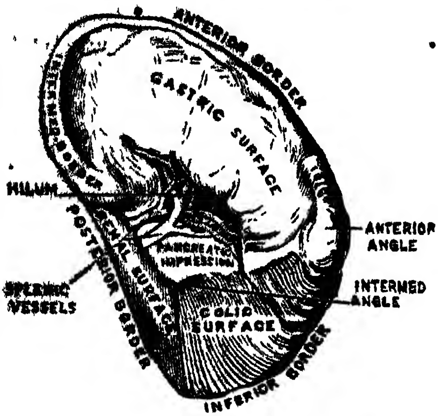


Fig. 16.—The Spleen (after Buchanan).

Structure of the Spleen.—The spleen is covered externally by peritoneum which invests it completely except at the hilum. This is the *serous coat*. Beneath the serous coat is the *fibrous coat* which not only covers the surface of the organ but sends in processes called *trabeculæ* into its interior. Cut a portion of the spleen and squeeze it. When the soft reddish brown pulpy matter called *splenic pulp* is squeezed out the trabecular framework will be seen.

The **Stomach** should now be inflated. Place one ligature in the first part of the duodenum and another above the cardiace orifice of the stomach. In the lesser curvature of the stomach nearer the pyloric end than the cardiac end is a notch called the *incisura angularis.* Opposite this notch there is a dilatation along the greater curvature of the stomach. This dilatation is called the *antrum pylori.* The portion of the stomach lying to the left of a line drawn from the incisura angularis to the left side of the pyloric antrum is called the *cardiac part* of the stomach, while the portion lying to the right side of the line is called the *pyloric part.* At the greater curvature to the right side of the pyloric antrum there is a slight groove called the *sulcus intermedius.* The constriction around the pyloric orifice is called the *duodeno-pyloric constriction.* The portion of the pyloric part of the stomach lying between the sulcus intermedius and the duodeno-pyloric constriction is called the *pyloric canal.* When the stomach is placed with it's long axis vertical the fundus lies above the level of the cardiac orifice. The average length of the stomach measured between two farthest points at the fundal and pyloric ends is about eleven inches in the Hindus. The greatest width is about six inches. The average capacity in Hindus is much larger and ranges between seventy and eighty ounces (Journal of Anatomy Vol: LIII Parts II and III, 1919).

Structure of the Stomach.—The wall of the stomach consists of four coats (1) serous, (2) muscular, (3) submucous, and (4) mucous. The *serous coat* is derived from the peritoneum which encloses the whole organ except along its greater and lesser curvatures where the vessels run. The *muscular coat* consists of unstriated muscle fibres arranged in three strata. From without inwards they are: (*a*) The *longitudinal layer* consisting of fibres passing from the cardiac to the pyloric orifice. They are

more developed at the curvatures of the stomach. (*b*) The *circular layer* consisting of fibres arranged circularly. They are more developed over the pyloric part of the stomach. Opposite the duodeno-pyloric constriction they are thickened into a ring called the *pyloric sphincter*. (*c*) The *oblique layer* consisting of fibres situated at the cardiac part of the stomach. Towards the right they present a free margin. The *submucous coat* is composed of loose areolar tissue and supports the blood vessels prior to their ramification in the mucous membrane. The *mucous membrane* is to be studied by opening the stomach along the lesser curvature. When thus opened the mucous membrane of the pyloric part is seen to be thrown into a number of longitudinal folds called *rugæ*. The student should note that these are temporary folds because they disappear during the distension of the organ. After the mucous membrane has been studied, it may be stripped off from the pyloric orifice to expose the pyloric sphincter.

Duodenum.—The mucous membrane of the duodenum should now be examined by slitting open its second portion along the right convex margin and extending the cut above and below. Notice the *aperture* common to the bile-duct and the main pancreatic duct, placed on a small elevation, the *duodenal papilla*, at the medial and back aspect of the second portion of the duodenum. Pass a fine probe through this opening and cut down along the probe. The ampulla of Vater and the openings of the bile and pancreatic ducts will be seen. The *plicæ circulares* begin to appear near the commencement of the second portion of the duodenum and they are very thickly set below the duodenal papilla.

The sympathetic plexuses lying in the posterior abdominal wall and their prolongations may now be examined. Look for two large ganglia, the cœliac ganglia. The left cœliac ganglion is found to the left side of the cœliac

artery and the right cœliac ganglion to the right side of the artery behind the inferior vena cava.

The **Cœliac Plexus** (Solar plexus) is the largest of the prevertebral plexuses of the sympathetic. It consists of a network of nerve fibres and ganglia which lie between the suprarenal glands and in front of the commencement of the abdominal aorta and crura of the diaphragm. It surrounds the orgin of the cœliac artery. Of the ganglia the chief are the two *cœliac* or *semilunar ganglia*, one in each half of the plexus. These are the largest ganglia in the body. The right cœliac ganglion is placed beneath the inferior vena cava. Each ganglion is joined by the greater splanchnic nerve of the same side at its upper part while the lower part of the ganglion remains as a separate small ganglion called the *aortico-renal ganglion* and is joined by the lesser splanchnic nerve. The cœliac plexus gives off filaments which descend on the abdominal aorta and accompany the various branches of this arterial trunk. The following subsidiary plexuses are derived from the cœliac plexus :—

(1) The *phrenic plexus* accompanies the inferior phrenic branch of the abdominal aorta to the under surface of the diaphragm where it communicates with the phrenic nerve. On the right side a small ganglion called the *ganglion phrenicum* is seen at the point of communication.

(2) The *superior gastric plexus* accompanies the left gastric branch of the cœliac artery and has been noticed while tracing the artery.

(3) The *hepatic plexus* issues from the cœliac plexus accompanies the hepatic artery to the liver and is also prolonged on the other branches of the hepatic artery. It is joined by filaments from the left vagus nerve. This plexus has been examined while tracing the hepatic artery.

(4) The *lienal* or *splenic plexus* accompanies the lienal artery to the spleen and distributes twigs along

the various branches of the artery. It is joined by filaments from the right vagus nerve. It has been noticed during the dissection of the lienal artery.

(5) The *suprarenal plexus* gets fibres mostly from the cœliac ganglion as also from the cœliac plexus. It accompanies the suprarenal artery to the suprarenal gland. It is connected above with the phrenic plexus and below with the renal plexus.

(6) The *renal plexus* derives its fibres from the cœliac ganglion, the cœliac and aortic plexuses. It accompanies the renal artery to the kidney and is joined by the lowest splanchnic nerve from above. A few small ganglia are found in this plexus. Filaments from it are given to the suprarenal plexus and to the spermatic or ovarian plexus.

(7) The *superior mesenteric plexus* is derived from the cœliac plexus. Its distribution with the branches of the superior mesenteric artery has been noted.

(8) The *abdominal aortic plexus* is placed upon the front and side of the abdominal aorta between the origins of the superior and inferior mesenteric arteries. It derives its fibres from the cœliac and superior mesenteric plexuses and from the ganglia of the abdominal part of the sympapathetic. It furnishes offshoots to the renal, the spermatic and the inferior mesenteric plexuses. It is continued downwards over the common iliac arteries to form the hypogastric plexuses.

(9) The *spermatic plexus* accompanies the testicular branch of the abdominal aorta to the testis. It derives its fibres from the aortic and renal plexuses. In the female the *ovarian plexus* accompanies the ovarian artery to the ovary.

(10) The *inferior mesenteric plexus* is derived from the aortic plexus. It accompanies the inferior mesenteric artery. Its distribution with the branches of the artery has been noted.

The **Kidneys** lie against the posterior abdominal wall, one on each side of the vertebral column. The upper end of each kidney is nearer the vertebral column than the lower end. The upper end of the right kidney lies against the twelfth rib, while, that of the left kidney lies against the lower border of the eleventh rib. The lower ends of the kidneys are about two inches above the iliac crest, that of the right side being a little lower. Their average length is about four inches, breadth about two inches and a half, and thickness a little more than an inch. Each kidney presents for examination two surfaces, two borders, and two extremities.

The anterior surface of both kidneys is convex, and looks forwards and lateralwards.

The *anterior surface of the right kidney* is covered by the right suprarenal gland close to the upper end of the organ. This portion is non-peritoneal. Below this the lateral portion of the anterior surface presents the *hepatic area* where the inferior surface of the liver lies in contact with it. This surface is peritoneal. Medial to this is the *duodenal area* close to the medial border of the kidney over which the second portion of the duodenum lies. This area is non-peritoneal. Below the hepatic area is the *colic area* over which the right flexure of the colon and the commencement of the transverse colon lies. This area is non-peritoneal. The extreme lower end of the anterior surface is covered by the coils of the small intestine.

The *anterior surface of the left kidney* presents at its upper and medial end a narrow *suprarenal area* covered by the left suprarenal gland. This area is non-peritoneal. The *splenic area* is narrow and close to the lateral border of the organ at its upper part. This area is peritoneal and lies in contact with the renal surface of the spleen. Between the suprarenal and splenic areas is the triangular

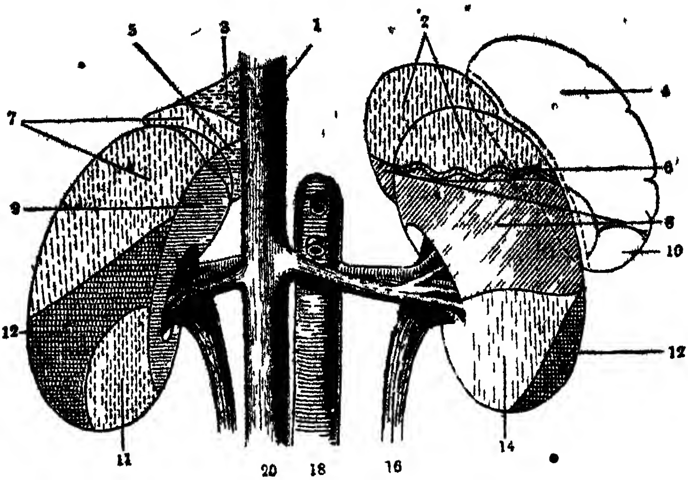


Fig. 17.—Diagram showing relation of kidneys, suprarenal glands and spleen (From Morris's System of Anatomy).

1. Caval area
2. Gastric area (peritoneal).
3. Hepatic area (non-peritoneal)
4. Gastric area of spleen.
5. Duodenal area (non-peritoneal)
6. Splenic artery.
7. Hepatic area (peritoneal)
8. Pancreatic area (non-peritoneal).
9. Duodenal area (non-peritoneal)
10. Colic area of spleen
11. Meso colic area
12. Colic area (non-peritoneal).
14. Meso-colic area.
16. Ureter
18. Aorta
20. Vena cava inferior.

gastric area covered by peritoneum. The postero-inferior surface of the stomach lies over this area. Below the gastric area and covering the upper part of the hilum of the kidney is the *pancreatic area* which is non-peritoneal and lies in contact with the posterior surface of the pancreas. At the lower and lateral part of the anterior surface is the *colic area*, which is non-peritoneal and covered by the left flexure of the colon and the commencement of the descending colon. Between the colic and pancreatic areas is the *jejunal area* which is peritoneal and covered by the coils of the small intestine.

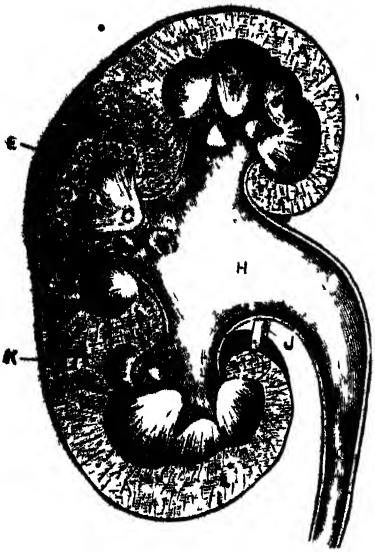
The *posterior surface of both kidneys* is less convex than the anterior and is embedded in adipose tissue called the *adipose capsule*. It is in relation with the twelfth rib and the diaphragm above. Below that the psoas major muscle lies medially and the quadratus lumborum laterally. On the left side the eleventh rib also lies behind the upper end of the kidney.

Borders.—The lateral border is markedly convex. The medial border is concave and presents a longitudinal fissure called the *hilum* which gives passage to the vessels and nerves of the kidney as also its duct called the ureter. The hilum leads into a cavity called the *renal sinus*. (The relative positions of the structures at the hilum should be noted. The renal vein lies in front, the ureter behind, and the renal artery lies between the two.)

The **Ureters** are two tubes which convey the urine from the kidneys to the bladder. It lies upon the psoas major muscle, crosses the common iliac or external iliac artery and enters the pelvis. It is covered by peritoneum. The right ureter passes into the pelvis behind the terminal part of the ileum while the left behind the descending colon. Both are crossed by the testicular vessels. The course of the ureters in the pelvis will be studied at a later stage.

Remove one kidney with a portion of the ureter and renal vessels. Divide it into two halves by a longitudinal incision carried from the lateral to the medial border of the organ. Note that the ureter as it approaches the hilum of the kidney shows a funnel-shaped dilatation, called the *pelvis of the ureter*. In the renal sinus the pelvis divides into two or three branches. These again subdivide into several short branches called *calyces* or *infundibula*.

Structure of the kidney.—From the cut lateral margin



A A. Cortical substance.
B B. Medullary substance.
C. Papilla.
D. Pyramid.
E. Uriniferous tubes.
F. Calyx.
G. Renal column.
H. Pelvis.
I. Ureter.
J. Artery.
K. Fibrous capsule.

Fig. 18.—Vertical section of kidney.

of the kidney strip off the fibrous *capsule* and reflect it towards the hilum. Note that at the renal sinus it becomes continuous with the wall of the pelvis of the ureter. The proper substance of the kidney consists of a peripheral portion, which is pale and granular, called the *cortical portion*, and of a central portion which is dark coloured, called the *medullary portion*. In the medullary portion a number of dark conical masses are seen called the *pyramids*. The bases of the pyramids are directed towards the cortical portion and their apices called the *renal papillæ* are embraced by the calyces. One or more papillæ may be thus embraced by one calyx. The cortical substance is prolonged between the pyramids forming the *renal columns* (columns of Bertini) and through these columns the renal vessels are seen as they pass.

Along the bases of some of the pyramids arterial arches may be seen.

The **Suprarenal Glands** are two small bodies situated on the superior extremities of the kidneys encroaching slightly on their anterior surfaces and medial borders.

The *right suprarenal gland* is triangular in shape. Its *anterior surface* presents a lateral triangular area which lies against the posterior surface of the liver and a medial narrow area covered by the inferior vena cava. At the upper part of this medial area is a small fissure, called the *hilum*, through which the right suprarenal vein emerges. The *posterior surface* lies against the diaphragm by its upper part. By its lower part which is concave it lies over the right kidney.

The *left suprarenal gland* is semilunar in shape. Its medial border is convex and lateral border concave. Its *anterior surface* at the upper part is covered by the stomach being separated from it by the omental bursa. At its lower part it is covered by the pancreas and the splenic vessels. The *hilum* through which the left suprarenal vein emerges is situated at the lower and medial part of this surface. The *posterior surface* is flat above where it rests against the diaphragm and deeply concave below where it lies against the medial border and upper end of the left kidney.

The diaphragm should now be studied. Remove the peritoneum from its abdominal surface and clean the muscular fibres, the crura and the central tendon, taking care of the vessels and nerves which ramify upon this surface of the muscle.

The **Diaphragm** is a musculo-tendinous arch which forms the partition between the thoracic and abdominal cavities. It forms the convex floor of the thorax and the concave roof of the abdomen. It arises from (1) the posterior surface of the xiphoid process by two fleshy

slips, (2) the inner surface of the cartilages of the lower six ribs interdigitating with the transversus abdominis, (3) the lateral lumbocostal arch, (4) the medial lumbocostal arch, and (5) the bodies of the upper two or three lumbar vertebræ by two crura.

The *lateral lumbocostal arch* (External arcuate ligament) is the thickened and arched upper part of the fascia covering the quadratus lumborum. It is attached medially to the transverse process of the first lumbar vertebra and laterally to the tip and lower border of the twelfth rib.

The *medial lumbocostal arch* (Internal arcuate ligament) is the thickened and arched upper part of the fascia covering the psoas major. It extends from the side of the body of the second lumbar vertebra and the tendinous crus of the diaphragm to the tip of the transverse process of the first lumbar vertebra.

The *crura* of the diaphragm are two in number. The right crus is larger and longer and arises by tendinous fibres from the anterior surfaces of the bodies of the upper three lumbar vertebræ and the intervertebral fibro-cartilages lying between them. The attachment of the left crus does not descend below the second lumbar vertebra. Where the aorta enters the abdomen the medial tendinous margins of the two crura are united together by a tendinous arch in front of the aorta.

From these sources of origin all the fibres of the muscle converge to be inserted into the *central tendon*. The slips originating from the xiphoid process are short and are separated from the muscle fibres originating from the costal cartilages by a cellular interval and hence no muscle fibres intervene between the pleural sac above and the peritoneal sac below at this situation. The muscle fibres arising from each crus divide into two bundles, a lateral and a medial. The lateral bundles diverge from each other

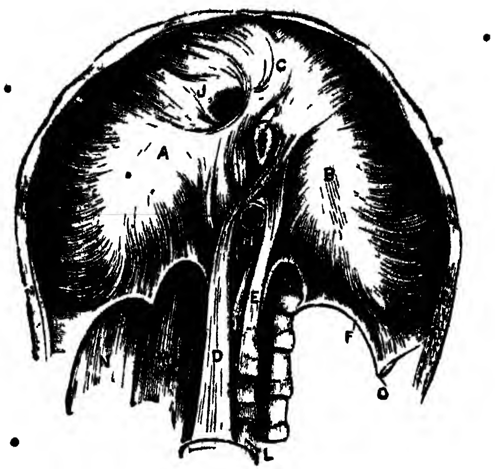


Fig. 19.—Abdominal surface af the diaphragm (after Wilson).

A. Right leaflet.
B. Left leaflet.
C. Central leaflet.
D. Right crus.
E. Left crus.
F. Lateral lumbo-costal arch.
G. Medial lumbo-costal arch.
H. Aortic opening.
I. Œsophageal opening.
J. Vena caval opening.
L. Fourth lumbar vertebra
M. Psoas major.
N. Quadratus lumborum.
O. Tip of last rib.

and are inserted into the central tendon. The medial bundles of the two sides decussate in front of the aortic and behind the œsophageal opening before being inserted into the central tendon.

The **Central Tendon of the Diaphragm** is the expanded tendinous part in the centre and blended with the pericardium above. It resembles a trefoil leaf in shape consisting of three leaflets. The right leaflet is the largest, the left the smallest, and the middle intermediate in size.

Openings in the Diaphragm.—There are three large and several small openings in the diaphragm. The three *large openings* are :—(1)..The *aortic opening* which is

osseoaponeurotic, and bounded in front by the fibrous arch which connects the medial margins of the two crura and behind by the body of the first lumbar vertebra. It gives passage to the aorta, the thoracic duct and the azygos vein. (2) The *œsophageal opening* is oval in shape and placed in the muscular part of the diaphragm, lying above, in front and to the left of the aortic opening. Behind it are the decussating medial bundles from the two crura. It gives passage to the œsophagus and the vagus nerves. (3) The *vena caval opening* is the highest of the three, quadrilateral in shape, and situated at the junction of the right and middle leaflets and entirely tendinous. It transmits the inferior vena cava and some filaments of the right phrenic nerve. *Small openings.*—The right crus is perforated by the three splanchnic nerves and the left crus transmits, in addition, the hemiazygos vein. The superior epigastric artery passes in the interval between the sternal and costal origins of the diaphragm. The musculo-phrenic artery pierces the costal origin of the diaphragm opposite the eighth or ninth rib.

Nerve supply.—The diaphragm is supplied by the phrenic and lower intercostal nerves.

THE POSTERIOR ABDOMINAL WALL.

In the posterior wall of the abdomen the dissector has to study the following :–

I. **Vessels.**—The abdominal aorta and its branches, the inferior vena cava and its tributaries, the azygos and hemiazygos veins, and the cisterna chyli with the commencement of the thoracic duct.

II. **Muscles and Fasciæ.**—The psoas major and minor, the iliacus and quadratus lumborum, and the fasciæ covering these muscles.

III. Nerves.—The sympathetic, the lumbar plexus with its branches, and the twelfth thoracic nerve.

I. VESSELS.

The abdominal aorta and those of its branches which have not been studied are now to be cleaned. The cisterna chyli together with the commencement of the thoracic duct and the azygos vein is to be looked for in the space between the aorta and the right crus of the diaphragm. The inferior vena cava is to be cleaned and its tributaries traced.

The **Abdominal Aorta** extends from the lower border of the twelfth thoracic vertebra at the aortic opening of the diaphragm to the level of the body of the fourth lumbar vertebra, a little to the left of the middle line. The coils of small intestine, the great omentum, the transverse colon, the liver, the stomach and the lesser omentum which covered the artery superficially have all been removed. The structures which are in direct relation with it are *In front*, the cœliac plexus, the lienal vein, the pancreas, the left renal vein, the third part of the duodenum, the mesentery proper, the aortic plexus and some lymph glands (*preaortic*). *Behind* it are the bodies and intervertebral discs of the lumbar vertebræ, the anterior longitudinal ligament and the left lumbar veins. To its *right side* are the azygos vein, the cisterna chyli, the thoracic duct, the right crus of the diaphragm and the inferior vena cava. To its *left side* are the left crus of the diaphragm, the left cœliac ganglion and the ascending part of the duodenum. On either side of the aorta are many lymph glands called *lateral aortic lymph glands*.

The **Branches of the Abdominal Aorta** are :—(1) inferior phrenic, (2) cœliac, (3) superior mesenteric, (4) middle suprarenal, (5) renal, (6) testicular, (in the male)

or ovarian (in the female), (7) inferior mesenteric, (8) lumbar, and (9) middle sacral. Of these the cœliac, the superior mesenteric and the inferior mesenteric arteries have been studied. The remaining branches are now to be examined.

The **Inferior Phrenic Arteries**, two in number, arise from the abdominal aorta just below the diaphragm above the origin of the cœliac artery and run upwards and lateralwards to the under surface of the diaphragm. The left phrenic artery passes behind the œsophagus while the right artery passes behind the inferior vena cava. Each phrenic artery gives off the *superior suprarenal artery* which supplies the suprarenal gland. At the posterior border of the central tendon each vessel divides into a medial and a lateral branch. The *medial branch* passes forwards and anastomoses with its fellow of the opposite side and with the musculophrenic artery. The *lateral branch* passes towards the side of the thorax and anastomoses with the musculophrenic and lower intercostal arteries. The companion *vein* terminates in the inferior vena cava.

The **Middle Suprarenal Arteries** (Middle capsular arteries), two in number, arise from the abdominal aorta on either side opposite the origin of the superior mesenteric artery. They pass lateralwards and slightly upwards to the suprarenal gland and anastomose with the suprarenal branches of the inferior phrenic artery above and renal artery below. The right *suprarenal vein* terminates in the inferior vena cava, but the left one terminates either in the left renal or inferior phrenic vein.

The **Renal Arteries** are two short thick branches arising from the abdominal aorta just below the origin of the superior mesenteric artery. Each artery passes lateralwards to the hilum of the kidney. The right one is longer than the left and passes behind the inferior vena cava.

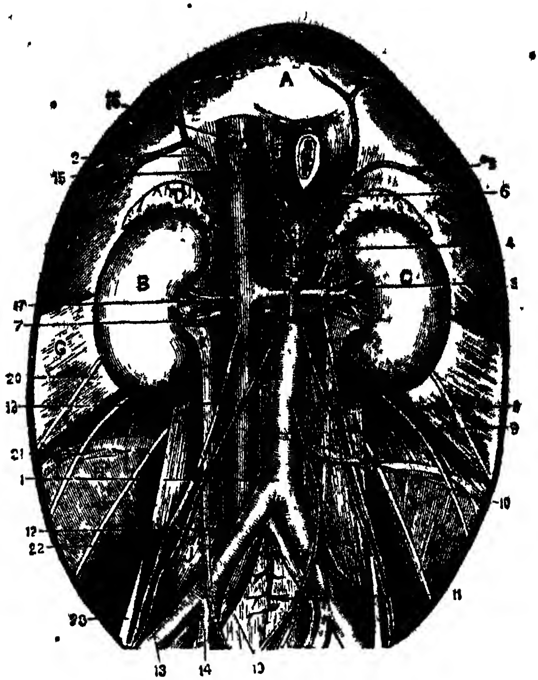


Fig. 20.—Abdominal aorta and inferior vena cava.

A. Diaphragm.
B. Right kidney.
C. Left kidney.
D. Suprarenal gland.
E. Œsophagus.
F. Right crus.
G. Transversus abdominis.
H. Iliacus.
I. Quadratus lumborum.
J. Psoas major.
K. Ureter.
1. Abdominal aorta.
2. Right inferior phrenic artery.
3. Left inferior phrenic artery.
4. Cœliac artery (cut).
5. Superior mesenteric artery (cut).
6. Superior suprarenal artery.
7. Renal artery.
8. Testicular artery.
9. Inferior mesenteric artery.
10. A lumbar artery.
11 Middle sacral artery.
12. Right common iliac artery.
13. External iliac artery.
14. Hypogastric artery.
15. Inferior vena cava.
16 Hepatic vein (cut).
17. Renal vein.
18. Testicular vein.
19. Common iliac vein.
20. Ilio-hypogastric nerve.
21. Ilio-inguinal nerve.
22. Lateral femoral cutaneous nerve.
23. Femoral nerve.

Before entering the hilum of the kidney each artery divides into three or four branches which lie between the renal vein in front and the ureter behind. These branches enter the substance of the kidney along the renal columns and have been examined in the longitudinal section of the kidney. Each renal artery gives off a branch, the *inferior suprarenal artery*, to the suprarenal gland and some twigs to the ureter and to the surrounding cellular tissue. The *renal veins* open into the inferior vena cava. The left one is the longer and receives in addition the left testicular or ovarian vein.

The **Testicular Arteries** are two long slender branches of the abdominal aorta which issue below the origin of the renal arteries. Each vessel passes downwards and lateralwards to the abdominal inguinal ring crossing the psoas major, the ureter and the external iliac artery. The right artery passes in front of the inferior vena cava and behind the terminal part of the ileum. The left passes behind the iliac part of the descending colon. Its course through the inguinal canal with the other constituents of the spermatic cord to the testis has been examined. The right *testicular vein* opens into the inferior vena cava while the left one opens into the left renal vein.

The **Ovarian Arteries** in the female correspond to the testicular arteries in the male. In the abdomen proper they have the same course as the testicular arteries and enter the pelvis by crossing the commencement of the external iliac artery. Their distribution to the ovaries will be noticed during the dissection of the pelvis. The *ovarian veins* end in the same way as the testicular veins.

The **Lumbar Arteries** usually four in number on each side, arise from the back part of the aorta. They run lateralwards upon the bodies of the lumbar vertebræ, beneath the sympathetic trunk and disappear behind the psoas major by passing beneath its fibrous arches at the

sides of the vertebræ. Its further course behind the muscle will be noticed later on. The *lumbar veins* open into the inferior vena cava.

The **Middle Sacral Artery** arises from the back of the aorta a little above its bifurcation. It descends in the middle line into the pelvis minor crossing the bodies of the fourth and fifth lumbar vertebræ. Its further course in the pelvis will be studied later on. The *middle sacral vein* opens into the left common iliac vein.

The **Common Iliac Arteries** are the terminal branches of the abdominal aorta. They commence a little to the left side of the fourth lumbar vertebra and pass downwards and lateralwards and divide opposite the lumbo-sacral articulation into the external iliac and hypogastric arteries. The right common iliac artery is longer than the left. Each artery lies upon the fourth and fifth lumbar vertebræ, is covered by peritoneum and the small intestines and is crossed by the ureter. The inferior vena cava, the right common iliac vein and the psoas major muscle lie on the lateral side of the right artery. The left common iliac vein lies medially and the psoas major muscle laterally to the left artery.

Four to six lymph glands called *common iliac lymph glands* lie on the sides of and behind the common iliac artery. Their efferents pass to the lateral aotric lymph glands.

The **Common Iliac Veins** are formed by the union of the external iliac and hypogastric veins. The right common iliac vein is placed at first behind and then lateral to the artery. The left common iliac vein is longer than the right and lies to the medial side of its companion artery and then passes behind the right common iliac artery to unite with the vein of the opposite side forming the inferior vena cava. *Tributaries.*—Each common iliac vein receives the ilio-lumbar vein and the left common iliac vein receives in addition the middle sacral vein.

The **External Iliac Artery** begins opposite the lumbosacral articulation at the bifurcation of the common iliac artery. It terminates behind the inguinal ligament midway between the symphysis pubis and the anterior superior iliac spine, where it becomes the femoral artery. It lies under cover of the ileum on the right side and the sigmoid colon on the left side. The external spermatic branch of the genito-femoral nerve and the testicular vessels cross the artery near its termination. The psoas major muscle lies at first laterally and then behind the artery. Its companion vein lies medially. The external iliac lymph glands, eight to ten in number, lie on the sides of the artery. The *branches* of the external iliac artery are (1) the *inferior epigastric* and (2) the *deep circumflex iliac*. Both have their origin just above the inguinal ligament. Their course and distribution have been examined during the dissection of the anterior abdominal wall. The *external iliac vein* lies at first medial to and then behind its companion artery on the right side, while on the left side it lies on the medial side of the artery throughout its course. The inferior epigastric and deep circumflex iliac veins open into it.

The **Cisterna Chyli** (Receptaculum chyli) is the expanded commencement of the thoracic duct. It is situated in front of the first and second lumbar vertebræ between the aorta and the right crus of the diaphragm. It is about two inches in length and becomes narrow above to be continued as the thoracic duct, which enters the thorax through the aortic opening in the diaphragm. The azygos vein lies on its right side. It receives the following efferent lymph vessels: (1) the *right* and *left common lumbar lymph trunks* which are formed by the efferent lymph vessels from the lateral aortic lymph glands lying at the sides of the inferior vena cava and aorta and join the lower end of the cisterna; (2) the *intestinal lymph*

trunk from the preaortic lymph glands, which joins the cisterna at its middle; (3) the two *lower thoracic lymph trunks* from the lower intercostal lymph glands which join the cisterna at its upper end.

The **Azygos Vein** (Vena azygos major) is the continuation upwards of the right ascending lumbar vein. It lies between the cisterna chyli and the right crus of the diaphragm and enters the thorax through the aortic opening with the thoracic duct.

The **Hemiazygos Vein** (Vena azygos minor) is the continuation upwards of the left ascending lumbar vein. It pierces the left crus of the diaphragm and enters the thorax.

The **Inferior Vena Cava** is the large venous channel which returns the blood from the lower extremities and the abdomen to the heart. It is formed by the union of the two common iliac veins on the body of the fifth lumbar vertebra. It ascends on the bodies of the vertebræ along the right side of the abdominal aorta to the under surface of the liver. It is then lodged in a deep groove, vena caval fossa, on the posterior surface of that organ. As it leaves the liver it pierces the central tendon of the diaphragm and opens into the right atrium. In front of it are the mesentery, the right testicular artery, the duodenum, the pancreas, the portal vein, and the posterior surface of the liver. Its tributaries are: the two common iliac, lumbar, right testicular or ovarian, renal, right suprarenal, right inferior phrenic, and hepatic veins.

Lymph Glands.—During the dissection of the abdomen the student has noticed numerous lymph glands. These may be grouped in the following manner:—(1) The *external iliac lymph glands*, about ten in number, arranged on the medial and lateral sides of the external iliac vessels; (2) the *common iliac lymph glands*, about six in number, lying behind and on the sides of the common

iliac artery; and (3) the *lumbar lymph glands*, situated in front of and behind the inferior vena cava and also on the left side of the abdominal aorta. They have been described with the vessels in connection with which they are found.

II. MUSCLES AND FASCIÆ.

The **Fascia Iliaca** covers the iliacus and psoas major muscles. It is attached laterally to the inner lip of the crest of the ilium, medially to the brim of the lesser pelvis, inferiorly it is attached to the inguinal ligament lateral to the external iliac vessels being continuous with the fascia transversalis; while behind the external iliac vessels it is prolonged into the thigh as the posterior wall of the femoral sheath. Superiorly above the level of the iliac crest it is prolonged over the psoas major muscle only as the *psoas sheath*. This sheath is attached medially to the intervertebral fibro-cartilages and the contiguous prominent margins of the bodies of the lumbar vertebræ by a series of fibrous arches; laterally it is continuous with the fascia covering the quadratus lumborum; superiorly it forms the thickened arched band called the *medial lumbo-costal arch*.

The **Fascia covering the Quadratus Lumborum** covers the muscle anteriorly. It is attached medially to the front of the transverse processes of the lumbar vertebræ where it is continuous with the psoas sheath; laterally it is continuous with the anterior layer of the lumbo-dorsal fascia; below it is attached to the ilio-lumbar ligament and the contiguous part of the iliac crest; and above to the tip and the lower border of the twelfth rib forming the thickened arched band called the *lateral lumbo-costal arch*.

The **Psoas Major** (Psoas magnus) arises (1) from the anterior surfaces of the transverse processes of all the

lumbar vertebræ, (2) from the intervertebral fibro-cartilages and the adjacent prominent margins of the bodies of the twelfth thoracic and all the lumbar vertebræ, and (3) from the tendinous arches which bridge over the lumbar vessels along the sides of the bodies of the lumbar vertebræ. The muscle passes along the brim of the lesser pelvis, receives the insertion of the iliacus on the lateral side of its tendon and is inserted into the lesser trochanter of the femur. *Nerve supply.*—It is supplied by branches from the second and third lumbar nerves.

The **Psoas Minor** (Psoas parvus) is sometimes present. It arises from the intervertebral fibrocartilage between the twelfth thoracic and first lumbar vertebræ and from the contiguous margins of those vertebræ. The muscle fibres soon end in a long tendon which passes along the front and medial aspect of the psoas major to be inserted into the iliopectineal eminence, pecten pubis and iliac fascia. It is supplied by a branch from first lumbar nerve.

The **Iliacus** arises (1) from the ala of the sacrum, (2) from the anterior sacro-iliac and ilio-lumbar ligaments, and (3) from the upper part of the iliac fossa and the inner lip of the iliac crest. It is inserted (1) into the lateral side of the tendon of the psoas major, (2) into the lesser trochanter of the femur in common with the tendon of the psoas major, and (3) into the surface of bone below the lesser trochanter. It is supplied by branches from the femoral nerve.

The **Quadratus Lumborum** arises (1) from the ilio-lumbar ligament, (2) from the adjacent part of the iliac crest, and (3) from the tips of the transverse processes of the lower two or three lumbar vertebræ. It is inserted (1) into the medial half of the lower border of the last rib and (2) into the tips of the transverse processes of the upper three or four lumbar vertebræ. It is supplied from the twelfth thoracic and first and second lumbar nerves.

III. NERVES.

Sympathetic Nerve.—The general plan of arrangement of the sympathetic system of nerves should be understood by the student. It consists of a series of ganglia which are connected by intervening cords extending from the first cervical vertebra to the coccyx. From this gangliated cord communicating branches are given off to the cranial and spinal nerves as also branches to the viscera along blood-vessels forming plexuses upon them.

The *lumbar portion of the sympathetic nerve* is continuous above with the thoracic portion behind the medial lumbo-costal arch. It is placed on the bodies of the lumbar vertebræ along the medial border of the psoas major muscle. On the right side it lies behind the inferior vena cava and on the left side it lies to the left of the aorta. Below it becomes continuous with the pelvic portion of the sympathetic by passing behind the common iliac artery. In the lumbar portion usually four ganglia will be noticed, from which *grey rami communicantes* pass laterally and branches of distribution pass medially. The grey rami communicantes, one from each ganglion, pass from all the four ganglia to the corresponding lumbar spinal nerves. The first and second and sometimes the third lumbar spinal nerves send *white rami communicantes* to the corresponding ganglia. The rami accompany the lumbar arteries. The *branches of distribution* are many filaments which pass medially to form chiefly the aortic plexus, but some pass downwards to join the hypogastric plexus.

Remove the psoas major muscle piecemeal on one side to expose the anterior primary divisions of the lumbar nerves which pass through it. Trace these nerves to the formation of the lumbar plexus. Trace the lumbar vessels further lateralwards.

Lumbar Plexus.—The anterior divisions of lumbar nerves are five in number. A branch from the twelfth thoracic nerve joins the first lumbar. This communicating branch together with the anterior divisions of the upper three lumbar nerves and a part of the anterior division of the fourth unite to form a series of loops called the lumbar plexus. The remaining part of the fourth lumbar nerve unites with the anterior division of the fifth lumbar to form the *lumbo-sacral trunk* which passes downwards to join the sacral plexus. The branches given off from the lumbar plexus are :—

(1) *White rami communicantes,* which pass from the

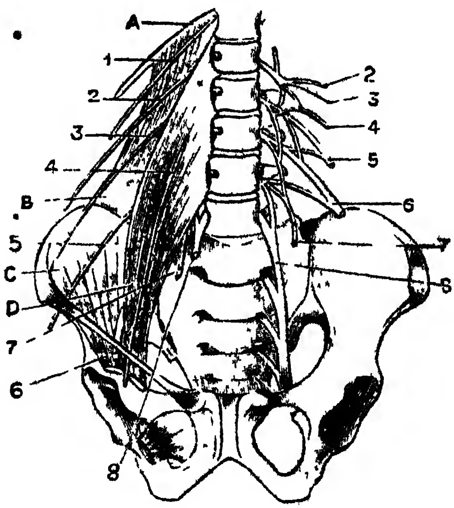


Fig. 21.—The lumbar plexus (after Cunningham).

A. Twelfth rib.
B. Quadratus lumborum.
C. Iliacus.
D. Psoas major.
1. Last thoracic nerve.
2. Ilio-hypogastric nerve.
3. Ilio inguinal nerve.
4. Genito-femoral nerve.
5. Lateral femoral cutaneous nerve.
6. Femoral nerve.
7. Obturator.
8. Lumbo-sacral trunk.

upper two or three lumbar nerves to the corresponding sympathetic ganglia.

(2) *Muscular branches.*—The psoas minor is supplied from the first lumbar, the psoas major from the second and third lumbar, the quadratus lumborum from the first and second lumbar nerves.

(3) The *ilio-hypogastric nerve* arises from the first lumbar nerve and appears at the lateral border of the psoas major at its upper part. It then passes obliquely downwards and lateralwards across the quadratus lumborum towards the iliac crest. Here it pierces the posterior part of the transversus abdominis and divides into a *lateral* and an *anterior cutaneous branch*. The former crosses the iliac crest to supply the gluteal region, while the latter has been traced to its destination.

(4) The *ilio-inguinal nerve* arises from the first lumbar nerve. It appears at the lateral border of the psoas major just below the ilio-hypogastric nerve. It then crosses the quadratus lumborum obliquely and near the front part of the iliac crest perforates the transversus abdominis. Its subsequent course and distribution have been examined during the dissection of the anterior abdominal wall.

(5) The *genito-femoral nerve* (genito-crural nerve) arises by two roots, one from the first lumbar and the other from the ventral division of the second lumbar. In passes through the psoas muscle and appears at its medial border. It then descends along the lateral aspect of the external iliac artery and divides into two branches, the external spermatic and lumbo-inguinal nerves. The *external spermatic nerve* (genital branch) crosses the external iliac artery to gain the abdominal inguinal ring, through which it passes to supply the cremaster muscle. In the female it passes with the round ligament of the uterus. The *lumbo-inguinal nerve* (crural branch) descends into the

thigh on the lateral side of the femoral artery. Its distribution to the skin of the upper and front part of the thigh will be examined during the dissection of the inferior extremity.

(6) The *lateral femoral cutaneous nerve* (external cutaneous nerve) arises by two roots from the dorsal divisions of the second and third lumbar nerves. It passes through the psoas major and emerges near the middle of its lateral border. It crosses the iliacus muscle obliquely and then passes through the notch below the anterior superior iliac spine and behind the inguinal ligament to the thigh.

(7) The *femoral nerve* (anterior crural nerve) arises by three roots from the dorsal divisions of the second, third and fourth lumbar nerves. It appears at the lateral border of the psoas major and descends between it and the iliacus and gives branches to the latter muscle. It passes behind the inguinal ligament to the thigh.

(8) The *obturator nerve* arises by three roots from the ventral divisions of the second third and fourth lumbar nerves. It pierces the medial border of the psoas major near the back part of the brim of the lesser pelvis and passes towards the upper part of the obturator foramen along the inner surface of the wall of the lesser pelvis. Through the obturator foramen it passes out of the pelvis accompanied by the obturator artery.

(9) The *accesory obturator nerve* is occasionally found. It arises either from the obturator nerve or from the third and fourth lumbar nerves. It passes downwards along the medial border of the psoas major and reaches the thigh by crossing the superior ramus of the os pubis.

The *anterior division of the last thoracic nerve* gives a communicating twig to the first lumbar nerve and then passes along the lower border of the twelfth rib across

the quadratus lumborum accompanied by the subcostal artery. Near the lateral border of the muscle it pierces the transversus abdominis and then runs forwards between the transversus and internal oblique muscles in the anterior abdominal wall where its distribution has already been seen.

The portions of the *lumbar arteries* covered by the psoas major are now exposed. They are four in number on either side and pass backwards to the intervals between the transverse processes where each artery gives off a dorsal branch. The *dorsal branch* passes backwards and opposite the intervertebral foramen gives off a *spinal branch* which enters the vertebral canal. The termination of the dorsal branch in the muscles and skin of the back will be seen during the dissection of the back. The upper three lumbar arteries after giving off their dorsal branches pass behind the quadratus lumborum while the lower one passes in front of it. Their subsequent course between the transversus and the internal oblique has been noted.

In front of the roots of the transverse processes of the lumbar vertebræ a thin longitudinal vein is seen joining the lumbar veins. This is called the *ascending lumbar vein* and is continued on the right side as the azygos vein and on the left side as the hemiazygos vein.

THE PELVIS.

Separate the pelvis with the fourth and fifth lumbar vertebræ from the trunk and place the part on the table.

Boundaries and Subdivision.—The pelvis is bounded behind by the sacrum and coccyx, in front and laterally by the two hip bones. Certain ligaments, fasciæ and muscles contribute to the formation of the pelvic wall, viz., posteriorly the sacrotuberous and sacrospinous

ligaments and the two piriformes muscles, anteriorly the urogenital diaphragm, and laterally the obturator membrane and obturator internus muscle. The portion of the pelvic cavity above the level of the pelvic brim is called the greater pelvis (false pelvis). This part has been included in the dissection of the abdominal cavity. The portion of the general abdominal cavity which is situated below the brim is called the lesser pelvis (true pelvis) and the student should now engage himself with the dissection of the lesser pelvis.

LESSER PELVIS IN THE MALE.

The relative positions of the chief viscera are as follows :—In front is the bladder with the prostate gland lying below it. Behind are the sigmoid colon and rectum. Between the bladder and the rectum are the vesiculæ seminales and the ductus deferentes.

The **Peritoneum** as it lines the lesser pelvis has been traced in a general way with the vertical tracing of the membrane in the abdominal cavity. The disposition of the peritoneum and its fossæ in the pelvis are now to be examined in detail. Traced along the posterior wall it encircles the sigmoid colon and holds it to the posterior wall by a loose fold called the *sigmoid mesocolon*. Lower down it covers the upper third of the rectum in front and at the sides but not posteriorly. Further down it covers the middle third of the rectum only on its anterior aspect and thence is prolonged on to the superior surface of the bladder covering the upper ends of the seminal vesicles. A depression is seen on either side of the rectum called the *pararectal fossa*. From the back part of the superior surface of the bladder at either end is a fold of peritoneum which extends backwards and lateralwards towards the sacrum. These folds are called the *sacro-genital folds* (pos-

terior false ligaments of the bladder). From the superior surface of the bladder the peritoneum is reflected laterally on to the lateral wall of the pelvis forming the *false lateral ligaments* of the bladder. On either side of the bladder a shallow peritoneal fossa is seen called the *paravesical fossa.* From the apex of the bladder the peritoneum is reflected on to the anterior abdominal wall covering the middle of umbilical ligament. This is called the *middle umbilical fold* (superior false ligament of the bladder). The fossa lying between the rectum behind and the bladder in front is called the *recto-vesical excavation.*

The pelvic fascia should now be displayed and studied. Detach the peritoneum from the right side of the pelvic wall towards the bladder and rectum. Next scrape away the extraperitoneal fatty tissue with the handle of the knife. The fascia lining the wall of the lesser pelvis is now seen. As the inferior extremity has been removed the obturator externus muscle and the remains of the muscles attached to the ischium and the pubis can now be cleared away. Then snip through the spine of the ischium near the base with bone pliers and saw through the ischium along a line extending from the lower part of the small sciatic notch to the lower part of the obturator foramen. Next saw through the ischium along a line extending from the upper part of the great sciatic notch to the upper part of the obturator foramen. The detached portion of bone should now be separated from the obturator internus muscle which arises from its inner aspect. The muscle itself should be cleaned, its tendon is to be tied with a piece of string and drawn forwards. A good view of the outer surface of the greater portion of the parietal pelvic fascia is thus obtained.

The Pelvic Fascia is divisible into two portions, a parietal portion which lines the wall of the lesser pelvis and a visceral portion which is prolonged on the viscera

to support them. The *parietal portion* is subdivided into three parts according to its situation. These are (1) the fascia of the piriformis, (2) the fascia of the obturator internus and (3) the diaphragmatic part of the pelvic fascia.

(1) The *fascia of the piriformis* is the back part of the parietal layer covering the piriformis muscle. It is attached to the front of the sacrum medial to the anterior sacral foramina. It is pierced by vessels and nerves which pass to the gluteal region through the great sciatic notch.

(2) The *fascia of the obturator internus* is the front part of the parietal layer covering the pelvic surface of the obturator internus muscle. Above it is attached to the back part of the ilio-pectineal line where it is continuous with the iliac fascia. Further in front it recedes from the ilio-pectineal line following the origin of the obturator internus and arches beneath the obturator vessels and nerve at the upper end of the obturator foramen forming the obturator canal. Traced further in front it is attached to the back part of the superior ramus of the pubis. Below it is attached to the falciform process of the sacro-tuberous ligament forming Alcock's canal and to the inferior rami of the ischium and pubis. Then it bridges over the triangular gap between the inferior ischio-pubic rami of the two sides forming the superior layer of the urogenital diaphragm. Behind it is attached to the anterior margin of the greater sciatic foramen and is continuous with the fascia of the piriformis.

(3) The *diaphragmatic part of the pelvic fascia* covers both surfaces of the pelvic diaphragm, i. e., the levator ani muscle. The layer that lines the inferior surface of the levator ani is called the *anal fascia*. The student can examine it by looking into the ischio-rectal fossa of which it forms the medial boundary. It is attached

above to the obturator fascia along the line of origin of the levator ani muscle from it. Below it passes to the margin of the anus following the insertion of the levator ani. The *superior layer of the diaphragmatic fascia* lines the upper surface of the levator ani muscle. It is attached *above* to the obturator fascia along a whitish line called the *white line.* This white line may be examined from its inner and outer aspects. By pulling the detached ischial spine backwards it will be put on the stretch and will be seen to extend from the spine to the back part of the symphysis pubis a little above its lower end. *Below* the superior layer is attached along the line of insertion of the levator ani muscle.

The *visceral layer* of the pelvic fascia or *fascia endopelvina* is the layer which passes medialwards from the white line towards the pelvic viscera. It blends inferiorly near the white line with the superior layer of the diaphragmatic fascia. Traced towards the median line it meets with the bladder in front, the rectum behind and the ductus deferens and vesiculæ seminales in the intermediate space. Thus it is divisible into three portions; viz., (*a*) a vesical layer, (*b*) a rectal layer, and (*c*) a recto-vesical layer.

The *vesical layer* passes medialwards to the front and lateral aspects of the bladder. If the bladder is pulled backwards it will be found to extend from the back part of the quadrilateral portion of the pubis to the bladder as a thickened band called the *true anterior ligament of the bladder.* If the bladder is pulled to the left the vesical layer will be seen to be attached to the lateral surface of the bladder as a thickened band called the *true lateral ligament of the bladder.* In males the vesical layer is prolonged on the prostate gland as its sheath.

The *rectal layer* is the posterior portion of the visceral layer. It passes to the side of the rectum and is prolonged

on it as a tubular sheath to the anal canal to be continuous with the anal fascia below.

The *recto-vesical layer* is the intermediate portion of the visceral layer which passes medialwards between the bladder in front and the rectum behind. At the lateral border of the vesiculæ seminales and the ductus deferentes it splits into two laminæ, an upper and a lower, which enclose those structures. At their medial border the two laminæ reunite to be continuous with the similar reunited layer of the opposite side. The splitting at the lateral border of the vesiculæ seminales can be demonstrated by incising the rectovesical layer at that line.

Sigmoid Colon (Pelvic colon).—Its position and attachment to the pelvic wall by sigmoid mesocolon have been examined.

The **Rectum** begins opposite the third sacral vertebra and descends along the front of the sacrum and coccyx with its concavity forwards (sacral flexure). Below the tip of the coccyx on a level with the apex of the prostate gland it curves backwards with its convexity to the front (perineal flexure) to end in the anal canal. At its upper third it is covered in front and at the sides by peritoneum; its middle third is covered in front only. Its lower third is uncovered by peritoneum as the membrane is reflected on to the vesiculæ seminales and bladder in the male and to the posterior vaginal wall and uterus in the female. Posteriorly the rectum is in relation with the sacrum and coccyx to which it is connected by loose areolar tissue; anteriorly it has in the male the base of the bladder, the ductus deferentes, the vesiculæ seminales and the prostate gland; while in the female it is in relation with the posterior wall of the vagina.

The Anal Canal is about an inch in length. It begins opposite the apex of the prostate and ends at the anus.

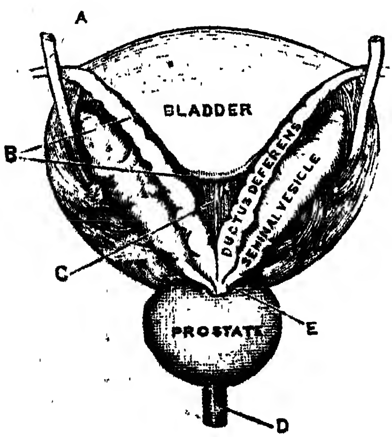
It is devoid of peritoneum and covered by a portion of the rectal layer of the pelvic fascia. The canal is encircled by the sphincter ani internus and supported by the levatores ani while the sphincter ani externus surrounds it at its termination.

The Urinary Bladder is the receptacle for the urine. Its shape and position vary with the amount of fluid contained in it. When empty it is placed entirely within the pelvic cavity reaching as far as the upper border of the symphysis pubis; when distended it protrudes into the abdominal cavity. The *empty bladder* presents for examination (1) a fundus or base (2) a vertex or apex, (3) a superior surface, (4) an inferior surface, (5) two lateral borders and (6) a posterior border. • The *fundus* or *base* is triangular, and directed towards the rectum. It is not covered by peritoneum and separated from the rectum by the rectovesical fascia, the ductus deferentes and the vesiculæ seminales. The *vertex* or *apex* is directed forwards towards the upper border of the symphysis pubis and from it the middle umbilical ligament (urachus) extends along the anterior abdominal wall to the umbilicus. The *superior surface* is covered by peritoneum and is in relation with the sigmoid colon and some coils of the small intestine. The *inferior surface* is directed downwards and is not covered by peritoneum. It is divisible into a posterior or prostatic area, lying against the base of the prostate gland, from which the urethra issues; and two infero-lateral surfaces which are separated from the symphysis pubis by a mass of fatty tissue called the *retropubic pad*. The *lateral borders* form the lateral boundaries of the superior surface and the *posterior border* forms its posterior boundary. At the junction of the posterior and lateral borders are the openings of the ureters.

Distend the bladder through one of the ureters by a blow pipe.

The *distended bladder* presents a fundus, a vertex, a postero-superior surface, an antero-inferior surface and two lateral surfaces. The *fundus* is slightly lowered and the *vertex* is directed upwards and forwards. The *postero-superior surface* is directed upwards and backwards. The *antero-inferior surface* is directed downwards and forwards, is devoid of peritoneum, and rests against the pubic bones and anterior abdominal wall. The *lateral surfaces* are uncovered by peritoneum at their lower parts.

The *false ligaments of the bladder* formed by the folds of peritoneum, viz., the two lateral, the superior, and the two sacro-genital folds have been described. Of the *true ligaments*, the two anterior and the two lateral have been studied in connection with the pelvic fascia; while the middle umbilical ligament (urachus) has been noticed during the dissection of the anterior abdominal wall.



A. Left ureter.

B. Line of reflection of peritoneum.

C. External trigone.

D. Urethra.

E. Ejaculatory duct of right side.

Fig. 22.—Dissection of the base of the bladder, showing the vesiculæ seminales and ductus deferentes (after Buchanan).

Ureters.—In the pelvis the ureter descends in front of the hypogastric artery to the level of the lower border of the great sciatic notch. It then turns medialwards and is crossed by the ductus deferens. Reaching the lateral angle of the bladder the ureter pierces its wall and passes obliquely through the wall for three-fourths of an inch before opening into the bladder.

The position and relations of the prostate gland should now be studied. Clean the rectovesical fascia enclosing the ductus deferens and vesicula seminalis on the right side. Trace the ductus deferens towards the base of the prostate gland.

The **Prostate Gland** is a conical body, about one and a quarter inches long from base to apex, and one and a half inches broad from side to side. Its *apex* is directed downwards resting on the superior fascia of the urogenital diaphragm. Its *base* is directed upwards towards the bladder. Its *anterior surface* lies behind the symphysis pubis to which it is attached by the pubo-prostatic ligaments or the anterior true ligaments of the bladder. Divide these ligaments and note the dorsal vein of the penis entering the pelvis below the pubic arcuate ligament to join the *pudendal plexus of veins* covering the prostate gland. The *posterior surface* lies against the rectum and can be felt by passing the finger through the rectum. The lateral surfaces are embraced by the levatores ani. Note that the gland is invested by a prolongation of the visceral layer of the pelvic fascia which forms its *sheath* and that it is pierced posteriorly at its base by the ejaculatory ducts. It encircles the first part of the urethra.

The Ductus Deferens (Vas deferens) has been examined in the abdominal inguinal ring through which it enters the abdominal cavity lateral to the inferior epigastric artery. In the lesser pelvis it crosses the umbilical artery,

the obturator nerve and the ureter and turns medialwards to the medial side of the vesicula seminalis. Here it is enclosed by the rectovesical fascia and presents a dilatation called the *ampulla.* Then it becomes narrow and joins the duct of the seminal vesicle to form the *ejaculatory duct.* The ejaculatory duct passes downwards to the base of the prostate. Its course through the prostate and opening into the urethra will be seen later on.

The **Vesiculæ Seminales** are two sacculated reservoirs for the fluid secreted by the testis, viz., semen. Each vesicle is about two inches and a half in length. Its *anterior surface* is in contact with the fundus of the bladder. Its *posterior surface* rests on the rectum from which it is separated by the rectovesical layer of the pelvic fascia. Its *upper end* is broader and directed upwards and lateralwards. Its *lower end* is constricted and terminates in a duct which joins the ductus deferens to from the ejaculatory duct.

The dissector should now display the hypogastric artery and its branches on the left side. For this purpose the peritoneum is to be peeled off and the blood vessels are to be traced. In clearing the pelvic fascia the branches of the sacral nerves are to be preserved.

The **Hypogastric Artery** (Internal iliac artery) arises opposite the lumbo-sacral articulation from the bifurcation of the common iliac artery. It passes to the upper margin of the greater sciatic foramen and then divides into an anterior and a posterior division. *Anteriorly* it is covered by peritoneum and crossed by the ureter, while *posteriorly* are the hypogastric vein and the lumbo-sacral nerve trunk. Lateral to it are the external iliac vein, the psoas major muscle and the obturator nerve. In the fœtus the hypogastric artery is twice the size of the external iliac artery and ascends on the back part of the anterior abdominal wall to the umbilicus, where it meets

with its fellow of the opposite side. The two hypogastric arteries pass through the umbilicus to the placenta along the umbilical cord and are now called the *umbilical arteries*. After birth the pelvic portion of the hypogastric artery remains patent and forms the hypogastric artery and its superior vesical branch. The remainder of the vessel along the abdominal parieties up to the umbilicus is converted into a fibrous cord, called the *lateral umbilical ligament* (obliterated hypogastric artery).

Branches of the Hypogastric Artery.—From the anterior division three visceral branches viz., the superior vesical, the inferior vesical and the middle hæmorrhoidal, and three parietal branches viz., the obturator, the internal pudendal and the inferior gluteal are given off. From the posterior division three parietal branches viz., the ilio-lumbar, the lateral sacral, and the superior gluteal are given off.

The **Superior Vesical Artery** is the pelvic part of the hypogastric artery which remains patent and extends to the side of the bladder. It gives off many small branches which supply the upper part of the bladder. From one of these branches a small twig, the *artery to the ductus deferens*, is given off which accompanies the duct to the testis.

The **Inferior Vesical Artery** usually arises in common with the middle hæmorrhoidal. It supplies the fundus of the bladder, the vesicula seminalis, the ductus deferens and the prostate.

The *vesical veins* commence in a venous plexus called the *vesical plexus*. This plexus is situated on the inferior surface of the bladder surrounding the base of the prostate gland. The vesical veins terminate in the hypogastric vein.

The **Middle Hæmorrhoidal Artery** usually arises in common with the inferior vesical. It supplies the wall

of the rectum and anastomoses with the superior and inferior hæmorrhoidal arteries.

Minute nerve filaments from the pelvic plexus accompany these visceral branches of the hypogastric artery.

The *middle hæmorrhoidal vein* begins in a venous plexus called the *hæmorrhoidal plexus*. This plexus consists of two parts an internal and an external. The internal part will be seen in the submucous tissue of the rectum. The external part surrounds the muscular coat of the rectum and is drained at its upper part by the superior hæmorrhoidal vein and at its lower part by the inferior hæmorrhoidal vein. The intermediate portion of the plexus is drained by the middle hæmorrhoidal vein which opens into the hypogastric vein.

The **Obturator Artery** passes downwards and forwards along the lateral wall of the lesser pelvis to the obturator canal at the upper part of the obturator foramen. In the pelvis it gives off some *iliac branches* to the iliac fossa which supply the bone and the iliacus; and a *pubic branch* which ascends along the back part of the os pubis and anastomoses with the pubic branch of the inferior epigastric artery. The further course and distribution of the obturator artery outside the pelvis will be seen during the dissection of the inferior extremity. The companion *vein* opens into the hypogastric vein.

The **Internal Pudendal Artery** (Internal pudic artery) passes downwards and lateralwards in front of the piriformis to the lower part of the greater sciatic foramen. It issues out of the pelvis between the piriformis and the coccygeus. The companion *vein* opens into the hypogastric vein.

The **Inferior Gluteal Artery** (Sciatic artery) passes downwards to the lower part of the greater sciatic foramen and issues out of the pelvis between the piriformis and the

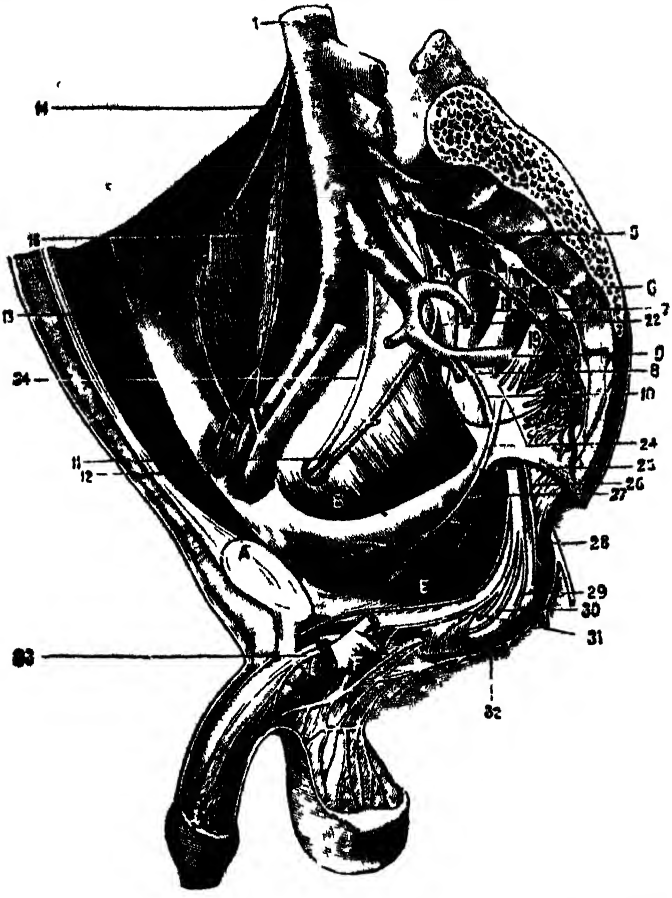


Fig. 28.—Right side of the interior of the male pelvis showing the branches of the hypogastric artery and the sacral and pudendal plexuses of nerves. (Modified from Testut).

A. Symphysis pubis.
B. Obturator externus.
C. Iliacus.
D. Psoas.
E. Levator ani.
F. Bulb.

1. Abdominal aorta.
2. Common iliac artery.
3. External iliac artery.
4. Hypogastric artery.
5. Ilio-lumbar artery.
6. Lateral sacral artery.

7. Superior gluteal artery.
8. Inferior vesical artery.
9. Inferior gluteal artery.
10. Internal pudendal artery.
11. Obturator artery.
12. Inferior epigastric artery.
13. Deep circumflex iliac artery.
14. Lateral femoral cutaneous nerve.
15. Genito-femoral nerve.
16. Fifth lumbar nerve.
17. Lumbo-sacral nerve trunk.
18. Second sacral nerve.
19. Third sacral nerve.
20. Fourth sacral nerve.
21. Fifth sacral nerve.
22. Superior gluteal nerve.
23. Branch from the ganglion of the sympathetic to the sacral nerve.
24. Branches to the viscera.
25. Nerve to levator ani.
26. Hæmorrhoidal branch of pudendal nerve.
27. Pudendal nerve.
28. Inferior gluteal nerve.
29. Lateral posterior scrotal nerve.
30. Medial posterior scrotal nerve.
31. Nerve to bulb of the urethra.
32. Long perineal branch.
33. Dorsal nerve of penis.
34. Obturator nerve.

coccygeus. Its companion *vein* opens into the hypogastric vein.

The **Ilio-lumbar Artery** passes upwards behind the obturator nerve, the external iliac vessels and the psoas major muscle. Behind the muscle it divides into a lumbar branch and an iliac branch. The *lumbar branch* supplies the psoas major and quadratus lumborum muscles and anastomoses with the lowest lumbar artery. It sends a *spinal branch* through the intervertebral foramen between the fifth lumbar vertebra and the sacrum. The *iliac branch* supplies the ilium and the iliacus and anastomoses with the deep circumflex iliac artery near the crest of the ilium. The *ilio-lumbar vein* opens into the common iliac vein.

The **Lateral Sacral Artery** is either a single trunk or consists of two branches, an upper and a lower. It descends in front of the piriformis and the sacral nerves lateral to the anterior sacral foramina to the tip of the coccyx, where it anastomoses with the middle sacral artery. Opposite the anterior sacral foramina it gives off *spinal branches* which supply the contents of the sacral canal and pass out of the canal through the posterior sacral foramina to supply the muscles on the back of the sacrum. The companion *veins* open into the hypogastric vein.

The **Superior Gluteal Artery** (Gluteal artery) is the continuation of the posterior division of the hypogastric artery. It descends between the lumbo-sacral nerve trunk and the first sacral nerve and issues out of the pelvic cavity through the greater sciatic foramen above the piriformis. The companion *vein* opens into the hypogastric vein.

Middle Sacral Artery.—Its origin has been seen during the dissection of the abdominal cavity. It descends in front of the sacrum along the middle line to the tip of the coccyx, where it supplies the glomus coccygeum. On either side it anastomoses with twigs from the lateral sacral artery. Its companion *vein* opens into the left common iliac vein.

The **Superior Hæmorrhoidal Artery** is the terminal branch of the inferior mesenteric artery. It descends through the sigmoid mesocolon and on reaching the rectum divides into two branches. These branches descend one on either side of the rectum and give twigs which pierce the muscular coat and anastomose in the submucous coat with the middle and inferior hæmorrhoidal arteries. The superior hæmorrhoidal vein drains the blood from the upper end of the hæmorrhoidal plexus and terminates in the inferior mesenteric vein. Some *rectal lymph glands* will be seen accompanying this vein.

The **Hypogastric Vein** (Internal iliac vein) is formed by tributaries corresponding to the branches of the hypogastric artery except the ilio-lumbar vein. It lies behind the hypogastric artery and joins the external iliac vein to form the common iliac vein.

Lymph Glands of the Pelvis.—Usually three groups of lymph glands are seen in the pelvis. (1) The *hypogastric glands* are found to surround the hypogastric vessels. (2) The *sacral glands* lie along the middle and lateral sacral vessels. (3) The *rectal glands* are seen in relation to the superior hæmorrhoidal vessels.

The **floor of the pelvis** should next be examined. It is formed by two muscles on each side. These are the levator ani and the coccygeus.

The **Levator Ani** arises (1) from the posterior surface of the quadrilateral part of the superior ramus of the os pubis, (2) from the white line of the pelvic fascia and (3) from the pelvic surface of the ischial spine. The fibres are directed downwards and backwards. The muscle is inserted by its posterior fibres into (1) the side of the lower part of the coccyx, and into (2) a median raphe called the *ano-coccygeal raphe* extending from the coccyx to the anus. By its intermediate fibres it is inserted into (3) the side of the anal canal between the internal and external sphincter muscles blending with the longitudinal fibres of the gut. By its anterior fibres it is inserted into (4) the sides of the prostate gland and (5) the central tendinous point of the perineum. The anterior fibres which enclose the prostate are named the *levatores prostatæ*.

The levator ani is supplied by a branch from the fourth sacral nerve and by the perineal branch of the pudendal nerve.

The **Coccygeus** is situated behind the levator ani. It arises from the pelvic surface of the ischial spine and sacro-spinous ligament. It is inserted into the side of the last piece of the sacrum and the upper part of the coccyx. It is supplied by a branch from the fourth and fifth sacral nerves.

The student should now dissect the nerves and nerve plexuses of the pelvis. The portion of the gangliated trunk of the sympathetic in the pelvis and the pelvic plexuses of the sympathetic should be studied. The lumbo-sacral nerve trunk and the anterior primary divisions of the five sacral nerves as also the coccygeal nerve should be examined.

The **Gangliated Trunk of the Sympathetic** is seen in the pelvis in front of the sacrum medial to the anterior sacral foramina and has upon it four or five ganglia. Lower down, the trunks of both sides converge and unite in front of the coccyx in a single minute ganglion called the *ganglion impar*. *Grey rami communicantes* pass from the ganglia to the sacral and coccygeal nerves. Some filaments from the upper ganglia join the pelvic plexus and others accompany the middle sacral artery. From the ganglion impar filaments are distributed to the *glomus coccygeum* (coccygeal body) which is a small body of the size of a small pea situated in front of the tip of the coccyx.

Sympathetic Plexuses in the Pelvis.—The *hypogastric plexus* is the continuation downwards of the aortic plexus and is joined by filaments from the lumbar ganglia. It is situated in front of the body of the last lumbar vertebra between the two common iliac arteries. Below it divides into two lateral portions called the *pelvic plexuses* which descend at the sides of the rectum. They are joined by visceral branches from the third and fourth sacral nerves and by a few filaments from the upper two sacral ganglia of the sympathetic. Each pelvic plexus gives off branches to the pelvic viscera. These branches follow the course of the arteries of the pelvis and form subsidiary plexuses which supply the rectum (*hæmorrhoidal plexus*); the bladder, the ductus deferentes and the seminal vesicles (*vesical plexus*); and the prostate gland (*prostatic plexus*). From the prostatic plexus branches pass forwards beneath the pubic arch to the penis and are called the *cavernous nerves*.

The **Sacral Plexus** is formed by the union of the lumbosacral trunk, the anterior division of the first sacral nerve and the greater portions of the anterior divisions of the second and third sacral nerves. It lies on the piriformis

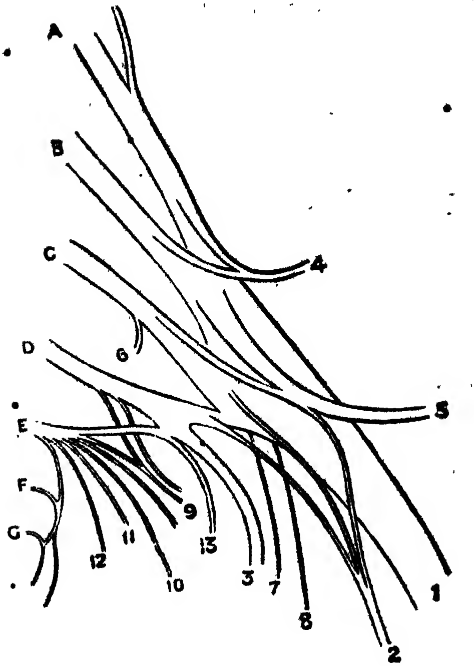


Fig. 24.—Diagram of the sacral, pudendal and coccygeal plexuses (after Ellis).

A. Lumbo-sacral nerve trunk.
B. First sacral nerve.
C. Second sacral nerve.
D. Third sacral nerve.
E. Fourth sacral nerve.
F. Fifth sacral nerve.
G. Coccygeal nerve.
1. Great sciatic nerve.
2. Posterior femoral cutaneous nerve
3. Pudendal nerve.
4. Superior gluteal nerve.
5. Inferior gluteal nerve.
6. Branch to piriformis.
7. Nerve to obturator internus.
8. Nerve to quadratus femoris.
9. Visceral branches of third and fourth sacral nerves.
10. Branch to levator ani.
11. Branch to coccygeus.
12. Perineal branch of fourth sacral nerve.
13. Perforating cutaneous branch.

muscle covered by the parietal pelvic fascia. The branches given off from the plexus are :—

(1) The **Superior Gluteal Nerve** which arises from the posterior aspect of the lumbo-sacral trunk and the first sacral nerve. It leaves the pelvis with the superior gluteal vessels through the upper part of the greater sciatic foramen above the piriformis.

(2) The **Inferior Gluteal Nerve** arises from the posterior aspect of the lumbo-sacral trunk and the first and second sacral nerves. It leaves the pelvis through the greater sciatic foramen below the piriformis.

(3) The **Posterior Femoral Cutaneous Nerve** (Small sciatic nerve) arises from the second and third sacral nerves and leaves the pelvis below the piriformis.

(4) The **Nerve to the Obturator Internus** arises from the front aspect of the lumbo-sacral trunk and the first and second sacral nerves. It leaves the pelvis below the piriformis. After giving a branch to the gemellus superior it crosses the ischial spine, reenters the pelvis through the lesser sciatic foramen and reaches the pelvic surface of the obturator internus.

(5) The **Nerve to the Quadratus Femoris** arises from the front aspect of the lumbo-sacral trunk and the first sacral nerve. It leaves the pelvis below the piriformis and supplies the gemellus inferior and quadratus femoris.

(6) The **Nerve to the Piriformis** arises from the second sacral nerve or from the first and second sacral nerves. It enters the piriformis on its anterior surface.

(7) The **Sciatic Nerve** (Great sciatic nerve) is the largest nerve in the body. It arises from the lumbo-sacral trunk and from the first three sacral nerves. It leaves the pelvis below the piriformis.

The **Pudendal Plexus** is not sharply demarcated from

the sacral plexus. In fact the sacral and pudendal plexuses were formerly described as parts of one and the same plexus, viz., the sacral plexus. It is formed by the remaining portions of the second and third sacral nerves together with the greater portion of the fourth sacral nerve. The branches given off from the pudendal plexus are :—

(1) The **Visceral Branches** which arise from the third and fourth sacral nerves. They supply the bladder and rectum and communicate with the pelvic plexuses of the sympathetic.

(2) The **Perforating Cutaneous Nerve** arises from the posterior aspects of the second and third sacral nerves. It pierces the sacrotuberous ligament and appears at the lower border of the gluteus maximus.

(3) The **Pudendal Nerve** (Pudic nerve) arises from the second, third and fourth sacral nerves. It leaves the pelvis between the piriformis and coccygeus muscles.

(4) The **Muscular Branches** arise from the fourth sacral nerve and supply the levator ani, the coccygeus and the sphincter ani externus.

The **Coccygeal Plexus** is formed by a filament from the fourth sacral nerve, the fifth sacral nerve and the coccygeal nerve. From this plexus a few filaments proceed to perforate the sacrotuberous ligament and supply the skin of the coccygeal region. Twigs from the fifth sacral nerve supply the coccygeus.

Detach the crura of the penis from the pubic bones. Remove the rectum and the bladder together with the prostate gland and penis in one mass by a circular cut around those structures. The vesiculæ seminales and the ductus deferentes will remain attached to the prostate by the ejaculatory ducts and the divided ureters will

remain attached to the bladder. Two muscles in the pelvic wall, the obturator internus and the piriformis, are now fully exposed and require to be studied.

The **Obturator Internus** arises (1) from the inner surface of the inferior rami of the ischium and os pubis around the obturator foramen, (2) from the pelvic surface of the medial part of the obturator membrane, (3) from the pelvic surface of the hip bone behind the obturator foramen as far as the greater sciatic notch and (4) from the lateral surface of the obturator fascia. From these origins the fibres converge to a tendon which passes out of the pelvis through the lesser sciatic foramen. In the gluteal region this tendon receives the insertion of the gemelli muscles and becomes inserted into the front part of the medial surface of the greater trochanter of the femur. The surface of the tendon in contact with the margin of the lesser sciatic notch is marked with furrows which play over the smooth cartilage-coated ridges on the bone underneath. A special branch from the sacral plexus supplies the obturator internus muscle.

The **Piriformis** arises (1) from the sacrum between the upper four anterior sacral foramina and from the grooves passing lateralwards from these foramina, (2) from the hip bone where it forms the upper border of the greater sciatic notch, and (3) from the sacrotuberous ligament. Its insertion into the upper border of the greater trochanter of the femur will be seen during the dissection of the gluteal region. It is supplied by a branch from the sacral plexus.

Remove the obturator internus muscle from the surface of the membrane closing the obturator foramen on the left side.

The **Obturator Membrane** is an oval membrane attached to the circumference of the obturator foramen except

at its upper part where a gap is left through which the obturator vessels and nerve pass. This is the *obturator canal.* The membrane gives origin to the obturator internus muscle on its pelvic surface and to the obturator externus muscle on its lateral surface.

Structure of the Bladder.—The wall of the bladder consists of four coats, serous, muscular, submucous and mucous. Distend the bladder by a blow pipe through one of the ureters and examine the coats.

The *serous coat* is derived from the peritoneum. It provides only a partial covering and has been described.

The *muscular coat* consists of three layers (*a*) the *external layer,* consisting of longitudinal fibres which arise from the posterior surface of the quadrilateral part of the superior ramus of the os pubis and the base of the prostate gland close by. They encircle the bladder in a longitudinal manner across the inferior surface, the vertex, the superior surface and the fundus, and come back to the base of the prostate to which they are attached. At the sides of the bladder the fibres pass obliquely. This external layer is called the *detrusor urinæ* muscle. (*b*) The *middle layer* consists of circular fibres which are arranged obliquely. These circular fibres are specially developed around the internal uretheral orifice forming the *sphincter vesicæ.* (*c*) The internal layer consists of longitudinal fibres which are thinly developed.

The *submucous coat* consists of areolar tissue in which the vessels and nerves ramify prior to their entrance into the mucous membrane.

Open the bladder by making an incision from the vertex along the inferior surface to the middle of the base of the prostate gland. Enlarge the incision backwards along the superior surface of the bladder.

The *mucous membrane* is thrown into irregular folds

except over a triangular area at the fundus of the bladder. These folds disappear during distension.

Interior of the Bladder.—The *internal urethral orifice* is situated at the most dependent part of the bladder at the base of the prostate gland. The mucous membrane behind the internal urethral orifice is slightly raised by a thickening of the underlying submucous tissue. This elevation is called *uvula vesicæ.* The *orifices of the ureters* are slit-like openings situated about an inch behind the internal urethral orifice at the postero-lateral angles of the bladder. Pass a bristle and note the oblique course of the ureters through the wall of the bladder for nearly three fourths of an inch. Between the orifices of the ureters is a transverse linear elevation of the mucous membrane called the *torus uretericus.* The *trigonum vesicæ* is the triangular space having its apex at the internal urethral orifice and its base at the torus uretericus. Its sides are formed by two lines joining the orifices of the ureters with the internal urethral orifice. The mucous membrane of the trigone is smooth and never thrown into folds as the submucous tissue here is not lax and the mucous membrane is firmly attached to the muscular coat.

Prostate Gland.—Next clean the prostate gland. Remove the fascial investment which envelopes it and forms its sheath. The *pudendal plexus of veins* is now exposed covering the anterior and lateral surfaces of the gland. This pelxus communicates above with the vesical plexus of veins situated between the base of the prostate gland and the bladder. Its communication with the dorsal vein of the penis has been noted. Clean this venous plexus, and expose the fibrous capsule which surrounds the gland and is quite distinct from its sheath. Note that the urethra is coming out of the prostate gland on the anterior surface close to the apex of the gland and that on the

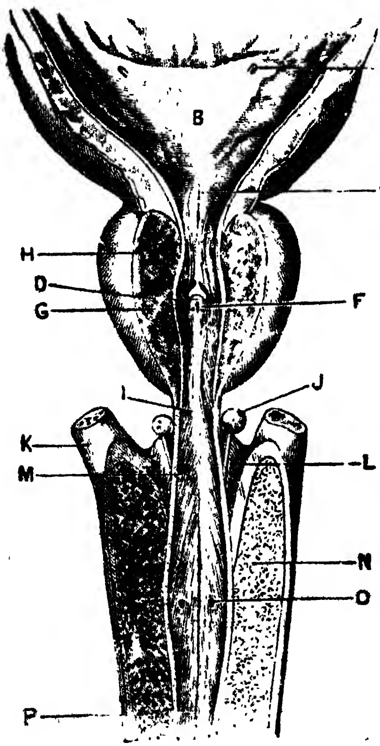
posterior surface an indistinct vertical groove along the middle line indicates the subdivision of the gland into two *lateral lobes.* But anteriorly these two lobes are continuous. Trace the *ejaculatory ducts* to their points of entrance into the posterior part of the base of the prostate. These ducts pass downwards and forwards through the substance of the prostate to open into the floor of the urethra. These openings will be seen when the urethra is opened up. Between the points of entrance of the ejaculatory ducts a portion of the prostate is demarcated which constitutes its *middle lobe.* Structurally the prostate gland consists of unstriated muscle fibres and glandular tissue.

Open up the urethra from the internal urethral orifice to the external urethral orifice in the middle line along the anterior surface of the prostate and between the two corpora cavernosa penis.

The **Urethra** extends from the internal urethral orifice in the bladder to the external urethral orifice at the end of the glans penis. Its length is variable, being usually eight to nine inches. It is subdivided into three portions, the prostatic, the membranous and the cavernous.

The *prostatic portion* is surrounded by the prostate gland. It is about one inch and a quarter in length and the widest and most dilatable part of the urethra. From above down it is spindle-shaped being dilated in the middle and narrow at either end. It is nearer the anterior than the posterior surface of the prostate gland. In its posterior wall or floor is a longitudinal ridge called the *urethral crest* (verumontanum) formed by a raising up of the mucous membrane. It is about three-fourths of an inch in length. On either side of the crest is a depression called the *prostatic sinus* in the floor of which minute orifices are seen. These are the openings of the ducts of prostatic glands. Below the most prominent part of the crest is the opening of a blind pouch called the *pros-*

tatic utricle (sinus pocularis). This pouch is directed upwards and backwards and is about one-fourth to half an inch in length. Just within the lateral margins of the opening of this pouch are seen the minute slit-like orifices of the ejaculatory ducts. The prostatic pouch corresponds developmentally to the uterus and vagina in the female.



A. Opening of ureter.
B. Trigonum vesicæ.
C. Uvula vesicæ.
D. Urethral crest.
F. Prostatic utricle.
G. Opening of ejaculatory duct.
H. Section of prostate.
I. Membranous part of urethra.
J. Bulbo-urethral gland.
K. Crus penis.
L. Portion of the bulb.
M. Commencement of bulbous portion.
N. Section of crus penis.
O. Opening of duct of bulbo-urethral gland.
P. Cavernous portion of urethra.

Fig. 25.—The bulbous, membranous and prostatic urethra and portion of the bladder laid open from above (after Wilson).

The *membranous portion* extends from the prostate gland to the commencement of the cavernous portion of the urethra. It is about three-fourths of an inch in length and is the shortest and narrowest portion of the urethra (with the exception of the external urethral orifice). It passes downwards and forwards, lies between the two layers of the urogenital diaphragm and is completely surrounded by the sphincter urethræ membranaceæ.

The *cavernous portion* (spongy portion) is about six inches in length and extends from the inferior fascia of the urogenital diaphragm to the external urethral orifice. It traverses the corpus cavernosum urethræ and presents two dilatations, one in the bulb, and another in the glans penis called the *fossa navicularis.* When attached to the body the cavernous portion at first passes forwards and upwards in front of the symphysis pubis and then bends downwards and forwards. The minute openings of the bulbo-urethral glands are seen in this portion of the urethra about an inch in front of its commencement at the membranous portion. Besides these there are many minute pit like recesses called *urethral lacunæ.* One of these is bigger than the rest and is situated in the roof of the fossa navicularis. It is called the *lacuna magna.*

The *external urethral orifice* is a vertical slit and is the narrowest part of the canal.

Structure of the Rectum and the Anal Canal.—The rectum and the anal canal have the same coats as the colon. The *serous coat* is formed by peritoneum and has been noted. The anal canal which is devoid of peritoneum receives instead a prolongation of the visceral layer of the pelvic fascia. In the *muscular coat,* the longitudinal muscular fibres are spread over the whole gut and not collected into three bands as in the colon. In the anal canal the levator ani muscle is inserted on the longitudinal muscle fibres between the internal and external sphincters

of the anus. The circular muscular fibres form a thick layer and are specially thickened at the lower part of the anal canal to form the *internal sphincter ani.* The *submucous coat* is loose and contains the blood-vessels including the hæmorrhoidal venous plexus. The *mucous membrane* is thick and in the rectum presents three transverse folds called *plicæ transversales recti* (Houston's valves). These are permanent folds and contain circular muscular fibres. One of them is situated along the right side of the rectum and the other two on the left side. The mucous membrane of the anal canal in its upper half is thrown into longitudinal folds called *rectal columns* (columns of Morgagni). The lower ends of these columns are connected by semilunar folds of mucous membrane called *anal valves.* Outside each valve is a small pouch called the *rectal sinus.* The lower half of the anal canal is lined by cuticle prolonged from the margin of the anus. At the junction of the cuticle and the mucous membrane is a lighter coloured line called the *white line.*

ARTICULATIONS OF THE PELVIS.

The student should now study the articulations of the pelvis. These include (1) the lumbo-sacral (2) the sacro-coccygeal, (3) the coccygeal, (4) the sacro-iliac and (5) the pubic articulations.

Lumbo-sacral Articulation.—The last lumbar vertebra articulates with the sacrum and the ligaments which connect together two typical vertebræ (see articulations of the trunk) are all seen in the lumbo-sacral joint. Thus (1, 2) the *anterior* and *posterior longitudinal ligaments* (anterior and posterior common ligaments) are continued over the anterior and posterior surfaces of the body of the last lumbar and first sacral vertebræ. (3) The *ligamenta*

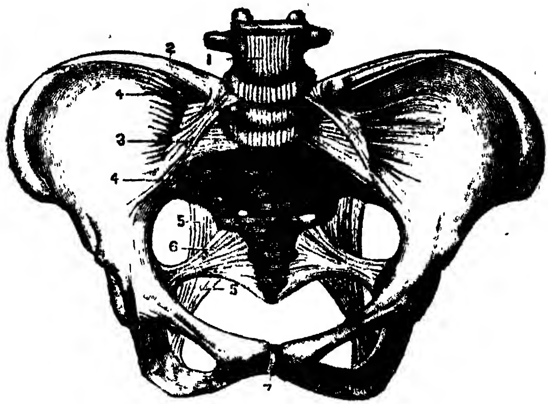


Fig. 26.—Ligaments of the pelvis (Sappey).

1. Anterior longitudinal ligament of vertebra.
2. Ilio-lumbar ligament.
3. Lumbo-sacral ligament.
4. Anterior sacro-iliac ligament.
5. Sacro-tuberous ligament.
6. Sacro-spinous ligament.
7. Fibro-cartilage of symphysis pubis.

flava (ligamenta subflava) extends from the anterior aspect of the inferior border of the laminæ of the last lumbar vertebra to the posterior aspect of the superior border of the laminæ of the first sacral vertebra. (4) The *articular capsules* surround the inferior articular processes of the last lumbar and the superior articular processes of the first sacral vertebra. Each capsule is lined by a synovial stratum. (5) The *interspinal ligament* lies between the spinous processes of the last lumbar and the first sacral vertebræ. (6) The *supraspinal ligament* connects the tips of the spinous processes of the same vertebræ. Two other ligaments are found in addition in this joint. These are the lumbo-sacral and ilio-lumbar ligaments. (7) The *lumbo-sacral ligament* is attached above to the lower border of the transverse process of the last lumbar vertebra and below to the ala of the sacrum. (8) The

ilio-lumbar ligament extends transversely from the tip of the transverse process of the last lumbar vertebra to the inner lip of the iliac crest. The articulation between the bodies of the last lumbar and the first sacral vertebræ is a synchondrosis having an intervertebral fibro-cartilage between them. This fibro-cartilaginous disc is very thick anteriorly.

The **Sacro-coccygeal Articulation** is also a synchondrosis. The articulating surfaces are united by an *intervertebral fibro-cartilage.* The joint has (1) an *anterior sacro-coccygeal ligament* which connects in front and (2) a *posterior sacro-coccygeal ligament* which connects behind the bodies of the last sacral and first coccygeal vertebræ and (3) the *lateral sacro-coccygeal ligaments* which connect the lateral angles of the sacrum to the transverse processes of the coccyx.

Coccygeal Articulations.—When the different segments of the coccyx are movable, fibro-cartilaginous discs are interposed between the separate segments which are connected anteriorly and posteriorly by anterior and posterior ligaments.

The **Sacro-iliac Articulation** is an amphiarthrodial joint. It is formed by the auricular surfaces of the sacrum and ilium. The ligaments connecting these bones are :—(1) The *anterior sacro-iliac ligament* which connects the anterior aspects of the auricular surfaces of the sacrum and ilium, (2) the *posterior sacro-iliac ligament* which extends from the rough area on the ilium behind its auricular surface to the first, second and third transverse tubercles on the posterior surface of the sacrum. The upper portion of the ligament passing to the first and second transverse tubercles is called the *short posterior sacro-iliac ligament.* The lower portion of the ligament passing from the posterior superior iliac spine to the third transverse tubercle on the back of the sacrum is called

the *long posterior sacro-iliac ligament.* (3) The *interosseous sacro-iliac ligament* lies covered by the posterior sacro-iliac ligament. It consists of strong, short fibres connecting the rough surfaces of the ilium and sacrum behind the auricular surfaces. (4) The *sacro-tuberous ligament* (Great sacro-sciatic ligament) is attached above to the posterior inferior iliac spine, to the third, fourth and fifth transverse tubercles of the sacrum and to the lateral margins of the sacrum and coccyx. From this broad attachment it passes downwards, forwards and lateralwards, becomes narrow and thickened in the middle and is again expanded at its attachment below to the medial border of the ischial tuberosity. From this attachment it is prolonged upwards as a sickle-shaped process called the *falciform process* to the free margin of which the obturater fascia is attached. (5) The *sacro-spinous ligament* (Small sacro-sciatic ligament) is triangular and is attached by its apex to the spine of the ischium and by its base to the lateral margins of the sacrum and coccyx in front of the sacro-tuberous ligament.

The **Symphysis Pubis** is a synchondrosis. The ligaments of the joint are :—(1) The *anterior pubic ligament* which stretches across the front aspect of the joint. (2) The *posterior pubic ligament* consists of scattered fibres lying on the posterior aspect of the joint. (3) The *superior pubic ligament* passes between the two pubic bones superiorly. (4) The *arcuate pubic ligament* (sub-pubic ligament) connects together the two pubic bones inferiorly. Above it is attached to the interpubic fibro-cartilage and below by its concave margin it forms the upper boundary of the foramen which transmits the dorsal vein of the penis. A *fibro-coartilaginous disc* is interposed between the cartilage-coated opposed surfaces of the pubic bones. A small synovial cavity is usually found inside this fibro-cartilage.

LESSER PELVIS IN THE FEMALE.

Position and Relations of the Viscera.—The bladder with the urethra occupies the front part of the pelvic cavity while the rectum is situated behind; between the bladder in front and the rectum behind are the uterus and the vagina and stretching laterally from the uterus to the side wall of the lesser pelvis are the broad ligaments of the uterus with certain structures enclosed between their layers. The loop of the sigmoid colon overhangs the uterus and the bladder.

The **Peritoneum** as it lines the posterior wall of the lesser pelvis completely encircles the sigmoid colon and holds it to the posterior pelvic wall by a loose fold called the sigmoid mesecolon. Then it covers the upper third of the rectum both in front and at the sides. It then covers the anterior surface of the middle third of the rectum and is reflected thence to the upper part of the posterior surface of the vagina. On either side of the rectum a fossa is seen called the *pararectal fossa*. Then it lines the posterior surface of the body of the uterus, its fundus and the upper two-thirds of its anterior surface. The pouch of peritoneum lying between the rectum behind and the uterus and posterior vaginal wall in front is called the *recto-uterine excavation* (pouch of Douglas). It is bounded on either side by a fold of peritoneum called the *sacro-uterine fold* which corresponds to the sacro-genital fold in the male. After lining the upper two-thirds of the anterior surface of the uterus the peritoneum is reflected to the superior surface of the bladder forming a pouch called the *vesico-uterine excavation*. This is bounded on either side by a fold of peritoneum extending from the postero-lateral angles of the bladder and called the *vesico-uterine fold* (posterior false ligament of the bladder). From either side of the uterus the peritoneum passes to the

side wall of the pelvis as a duplicated fold called the *broad ligament of the uterus* which encloses between its two layers the uterine appendages. From the superior surface of the bladder the peritoneum is reflected to the side wall of the pelvis forming the *lateral false ligaments of the bladder.* The *paravesical fossa* is seen on either side of the bladder as in the male. From the bladder the peritoneum passes on to the posterior aspect of the anterior abdominal wall as in the male.

The broad ligament of the uterus and some of the structures enclosed between its two layers may now be identified. These are (1) the uterine tube lying along its superior border; (2) the ovary and its ligament lying below and behind the uterine tube, (3) the round ligament placed below and in front of the uterine tube; besides these the other structures enclosed within the layers of the broad ligament which will be identified later on are:— (4) the epoophoron and paroophoron: (5) the uterine and ovarian vessels; (6) nerve filaments; and (7) connective tissue and unstriated muscle fibres. The portion of the broad ligament between the ovary and the uterine tube is called the *mesosalpinx.* The portion of it that extends backwards to the ovary is called the *mesovarium.*

The **Pelvic Fascia** is now to be exposed on the right side by reflecting the peritoneum together with the broad ligament of the uterus. The parietal layer has an arrangement similar to that in the male. The vesical layer and the rectal layer of the visceral portion have the same arrangement as in the male. The recto-vesical layer of the male pelvis is represented by the recto-vaginal layer which is pierced by the vagina in front of the rectum and is prolonged as a sheath on the vaginal wall.

The Rectum corresponds to that in the male with this difference that it is in relation anteriorly with the recto-uterine excavation and vagina.

The **Bladder** in the female is in relation posteriorly with the neck of the uterus and the anterior wall of the vagina. The prostate gland, the ductus deferens and the vesiculæ seminales are absent in the female.

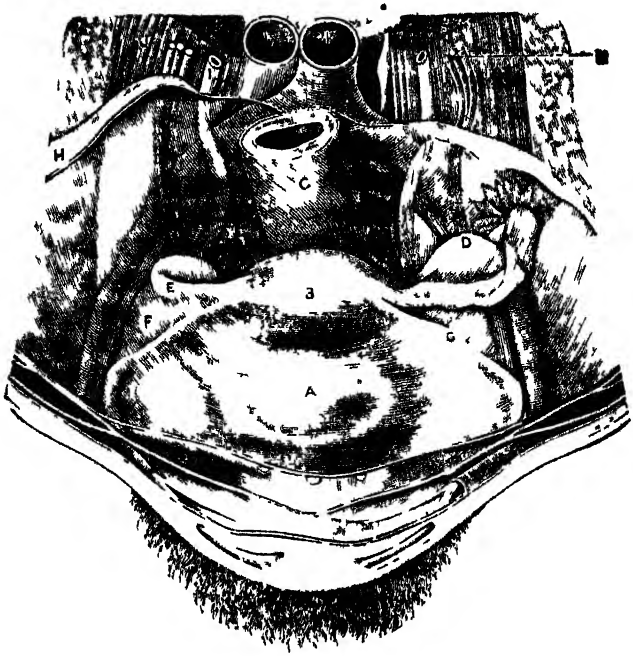


Fig 27 Female pelvic viscera from above. The uterine tube and ovary have been raised above their proper position (after Testut).

A. Bladder
B. Uterus
C. Sigmoid colon
D. Ovary
E. Uterine tube
F. Broad ligament
G. Round ligament.
H. Peritoneum.
I. Ureter
J. Psoas major muscle.
K. Aorta.
L. Vena cava inferior.
M. Ovarian vessels.

Ureters.—The pelvic portion of the ureter is longer in the female. At the upper part of its course it has the same relations as in the male but in the lower part of the course it passes beneath the lower border of the broad ligament to the side of the upper part of the vagina and before opening into the postero-lateral angle of the bladder lies in front of the upper part of the vagina. It is crossed by the uterine artery.

The **Urethra** in the female is about an inch and a half in length. It passes downwards and forwards, pierces the urogenital diaphragm and opens into the vestibule. It lies against the anterior vaginal wall.

Divide the peritoneum at the bottom of the vesico-uterine excavation by a transverse incision and draw the bladder forwards from the anterior surface of the neck of the uterus and the vagina.

The **Uterus** is placed above the vagina between the bladder and the rectum. It is piriform in shape, about three inches in length, two inches in breadth and one inch in thickness. It is divided into a fundus, a body and a cervix or neck.

The **fundus** is the rounded portion lying above the level of the uterine tubes. It is entirely covered by peritoneum and is directed upwards and forwards.

The **body** has an anterior and a posterior surface and two lateral borders. The *anterior surface* is convex and is covered in its upper two thirds by peritoneum. The lower third lies against the fundus of the bladder. The *posterior surface* is convex and is covered entirely by peritoneum. Each *lateral border* is joined above by the uterine tube; a little below is attached the round ligament in front and the ligament of the ovary behind.

The **cervix** or neck is about an inch in length and marked off from the body by a slight constriction on the surface which is called the *isthmus*. The cervix lies partly above

the vagina and partly inside the vagina. The portion lying above the vagina is called the *supravaginal portion* and the part projecting into the vagina is called the *vaginal portion.* The *anterior surface* of the cervix is not covered by peritoneum and is in relation with the fundus of the bladder; the *posterior surface* is entirely covered by peritoneum.

The **Vagina** is the passage extending from the vulva to the uterus and is placed between the bladder in front and the rectum behind. Its length is about three inches. It is not a patent canal, its walls lie in apposition. It is constricted at either end and slightly wider in the middle. Its upper end is attached around the cervix of the uterus and if the finger is passed up the vagina the hard projecting end of the cervix can be felt. The deep recess felt between the posterior vaginal wall and the cervix is called the *posterior fornix.* The shallower recess felt between the cervix and anterior vaginal wall is called the *anterior fornix,* and the recesses felt between the lateral vaginal wall and the cervix are called the *lateral fornices. Anteriorly* the vagina is in relation with the base of the bladder and the urethra while *posteriorly* from above downwards it is in relation with the recto-uterine excavation, the rectum and the perineal body. Laterally it is supported by the levator ani muscles and the ureters lie in contact with it at its upper part.

The **Uterine Tubes** (Fallopian tubes) are two in number and serve the purpose of conducting the ova from the ovary to the uterine cavity. Each tube is about four inches in length and occupies the upper border of the broad ligament. It consists of four portions, the pars uterina tubæ, the isthmus, the ampulla, and the infundibulum. The *pars uterina tubæ* is the portion that passes through the wall of the uterus and opens into the uterine cavity. The *isthmus* is the constricted portion passing

lateralwards from the body of the uterus and forms nearly one-third of the length of the tube. The *ampulla* is the dilated lateral half of the tube and ends laterally in a funnel-shaped expansion called the *infundibulum*, the base of which is surrounded by a number of fringe like processes called the *fimbriæ*. One of these fimbriæ is longer than the others and is attached to the tubal extremity of the ovary. It is called the *ovarian fimbria*. The minute orifice by which the uterine tube communicates at its lateral end with the peritoneal cavity is called the *ostium abdominale*.

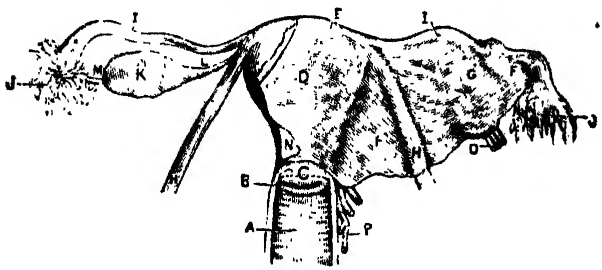


Fig. 28.—Uterus and its appendages seen from the front (after Wilson).

A. Vagina.
B. External uterine orifice.
C. Cervix.
D. Body of uterus.
E. Fundus.
F. Broad ligament.
G. Ovary covered by broad ligament
H. Round ligament.
I. Uterine tube.
J. Fimbriated extremity of uterine tube.
K. Ovary.
L. Ligament of the ovary.
M. Fimbria ovarica.
N. Peritoneum covering anterior surface of uterus and its continuity with anterior layer of broad ligament shown.
O. Ovarian vessels.
P. Uterine vessels.

The **Ovaries** correspond to the testes in the male. They are two oval shaped solid bodies placed in the posterior part of the broad ligament below the uterine tubes. Each organ occupies a shallow peritoneal fossa (*ovarian fossa*)

below the external iliac vessels. The surface of the ovary is smooth before puberty but after that period it becomes puckered due to the escape of the ova by the bursting of the ovarian follicles. It presents for examination two surfaces, two borders and two extremities. The *medial surface* is partly covered by the uterine tube. The *lateral surface* lies against the ovarian fossa. The *anterior border* or *hilum* is straight and is attached to the broad ligament by the mesovarium. Through it the blood vessels and nerves of the ovary pass. The *posterior border* is convex and free. The *upper* or *tubal extremity* is attached to the fimbriated end of the uterine tube by the ovarian fimbria. The *lower* or *uterine extremity* is connected with the side of the uterus by the ligament of the ovary.

The **Round Ligament** is a fibro-muscular band which proceeds from the body of the uterus in front of and just below the attachment of the uterine tube. It runs lateralwards and forwards between the layers of the broad ligament and enters the abdominal inguinal ring by turning lateral to the inferior epigastric artery.

Blood-vessels.—Three vessels peculiar to the female pelvis viz., the ovarian, the uterine and the vaginal arteries require to be studied. Reflect the peritoneum and trace these vessels on the left side.

Ovarian Artery.—Its origin from the abdominal aorta and its course up to the brim of the lesser pelvis has been described. Crossing the external iliac vessels it enters between the two layers of the broad ligament and passes to the anterior border of the ovary with a tortuous course. Here it gives off many small twigs which enter the ovary. It also sends twigs to the uterine tube and the round ligament and anastomoses with the branches of the uterine artery. The *ovarian veins* emerging from the anterior border of the ovary form a tortuous plexus called the *pampiniform plexus* between the two layers of the broad

ligament. Two veins emerge from the plexus and accompany the ovarian artery and ultimately unite to form a single vein, which opens on the right side into the inferior vena cava and on the left side into the left renal vein.

The **Uterine Artery** is a branch of the anterior division of the hypogastric artery. It proceeds medialwards along the lower border of the broad ligament to the cervix and sends several branches to the vagina. It then ascends between the two layers of the broad ligament in a tortuous manner along the side of the uterus giving several branches to it. It also gives twigs to the uterine tube, the round ligament and the ovary and anastomoses near its termination with branches of the ovarian artery. The *uterine veins* begin in a plexus at the side of the uterus called the *uterine venous plexus* situated between the two layers of the broad ligament. They terminate after a tortuous course in the hypogastric vein.

The **Vaginal Artery** arises from the anterior division of the hypogastric artery. It descends on the vagina and supplies it. It also sends twigs to the base of the bladder and to the rectum and anastomoses with the vaginal branches of the uterine artery. The *vaginal veins* begin in a plexus situated around the vagina called the *vaginal venous plexus* and terminate in the hypogastric vein.

Nerves.—The following three plexuses of nerves require to be examined in the female pelvis :—(1) The *uterine plexus*, which is derived from the pelvic plexus and accompanies the uterine artery to the uterus. (2) The *vaginal plexus* which is derived from the pelvic plexus and accompanies the vaginal artery to the vagina. (3) The *ovarian plexus* which is derived from the aortic and renal plexuses and accompanies the ovarian artery to the ovary.

Divide the blood vessels passing to the viscera and remove the viscera in one mass by carrying the knife

circularly around them. Separate the bladder and the urethra from the mass and open up the bladder along the middle line of its inferior surface and extend the incision along the ventral wall of the urethra.

Structure of the Bladder and Urethra.—The bladder has the same structure as in the male. The urethra presents a muscular coat consisting of an external layer of longitudinal and an internal layer of circular fibres. The submucous coat connects the muscular with the mucous coat. The mucous membrane is thrown into longitudinal folds.

Next separate the uterus and vagina together with the broad ligaments from the rectum.

The **Epoophoron** (Parovarium or organ of Rosenmuller) consists of a few short vertical tubules and a horizontal tubule. Hold the broad ligament to the light and stretch the portion of it lying between the ovary and the uterine tube. A number of vertical tubules called the *ductuli transversi* will be seen radiating from the ovary towards the uterine tube. Joining the bases of these tubules a single tubule will be seen ending blindly near the uterus. This is called the *ductuli longitudinalis epoophori* (duct of Gartner). Laterally it ends sometimes in one or more vesicles called the *appendices vesiculosæ* (hydatids of Morgagni).

The **Paroophoron** consists of a few scattered tubules seen between the epoophoron and the body of the uterus.

Structure of the Uterine Tube.—Three coats enter into the formation of the uterine tube—serous, muscular, and mucous. The *serous coat* is formed by the peritoneum of the broad ligament. The *muscular coat* consists of an external layer of longitudinal and an internal layer of circular fibres. The *mucous membrane* is thrown into longitudinal folds and will be seen by opening up the infundibulum and the ampulla of the tube.

Structure of the Vagina.—Open up the vagina along its sides. The wall of the vagina consists of a muscular coat, a layer of erectile tissue, and a mucous coat. The *muscular coat* is the outermost and formed by an external layer of longitudinal and an internal layer of circular unstriated muscle fibres. The *erectile tissue* consists of a layer of connective tissue in which are seen a venous plexus and unstriated muscle fibres. The *mucous membrane* is the innermost coat and presents two longitudinal folds one on the anterior and the other on the posterior wall. These folds are called the *columnæ rugarum* from each side of which transverse folds are given off lateralwards.

In the vaginal portion of the cervix observe that at its lower end is an opening called the *external uterine orifice* (Os uteri externum) by means of which the uterus communicates with the vagina. This orifice is bounded by two thick lips; of which the anterior one is the thicker while the posterior one is the longer. The fornices between the vaginal portion of the cervix and the vaginal wall are clearly seen.

Divide the uterus by a coronal section by inserting the knife over the fundus between the uterine tubes and carrying it along the lateral borders of the uterus to the end of the cervix. The uterus is thus divided into two halves, an anterior and a posterior.

The *uterine cavity* is triangular in shape where it is confined to the body. Its base is at the fundus and the apex communicates with the cavity of the cervix by a narrow orifice called the *internal uterine orifice* (Os uteri internum). At each upper and lateral angle is the minute orifice of the uterine tube. The *canal of the cervix* is wider in the middle and constricted at the internal and external uterine orifices.

Structure of the Uterus.—The uterus consists of three

coats. The serous coat is formed by peritoneum. The muscular coat is bulky and is formed by unstriated muscle fibres. The mucous membrane lining the cavity of the body is smooth. In the canal of the cervix the mucous membrane presents two longitudinal ridges one on its anterior and the other on its posterior wall. From these longitudinal ridges oblique folds, called the *palmate folds*, pass upwards and lateralwards, presenting the appearance of a branching tree. This arrangement is known as the *arbor vitæ uterinæ*.

Structure of the Rectum and Anal Canal.—The coats are the same as in the male.

THE THORAX.

The dissector of the thorax usually starts his work on the eleventh working day, that is to say, ten days after the subject has been put on the table for dissection.

Before commencing with the actual dissection of the thorax, the student should study the parts constituting its framework from the hanging skeleton in the dissecting-room. The *framework of the thorax* is formed partly by bones and partly by cartilages and has a conical shape. Its *anterior wall* is formed by the sternum and the costal cartilages; its *posterior wall* is formed by the twelve thoracic vertebræ with the intervening fibro-cartilages and the vertebral ends of the ribs as far as their angles. Its *lateral walls* are formed by the ribs, separated from each other by the intercostal spaces which are closed by the intercostal muscles in the recent state. Its

upper opening or *inlet* is bounded in front by the upper margin of the sternum, on each side by the first rib and its cartilage and behind by the first thoracic vertebra. Its *lower opening* or *outlet* is bounded in front by the xiphoid process and the cartilages of the seventh, eighth, ninth, tenth and eleventh ribs ; on each side by the twelfth rib and its cartilage and behind by the twelfth thoracic vertebra. The diaphragm closes the lower opening in the recent state forming the floor of the thorax.

THE THORACIC PARIETES.

Besides the bony and cartilaginous framework, the dissector has to study the muscles, membranes, the vessels and the nerves in the thoracic wall. The remains of the muscles attached to the thoracic wall, viz, the pectoralis major and minor, the serratus anterior, the rectus abdominis, the obliquus externus abdominis, the latissimus dorsi and the subclavius, are to be removed. The cutaneous vessels and nerves near the midaxillary line and the margin of the sternum are to be preserved. The intercostal muscles fill up the greater part of the intercostal spaces on each side of the wall of the thorax and are arranged on each space in two layers, an external and an internal.

The **External Intercostal Muscles** are eleven in number on each side of the thorax. Each muscle arises from the lower border of the rib above and is inserted into the outer lip of the upper border of the rib below. The muscle fibres from their origin are directed downwards, forwards and medialwards. The first external intercostal muscle arises from the outer border of the first rib. Anteriorly each intercostal muscle extends to the junction of the rib with its cartilage. From that point to the margin of the sternum the muscle is prolonged as a membrane

called the *anterior intercostal membrane.* In the tenth and eleventh intercostal spaces however the muscle fibres extend to the anterior ends of the intercostal spaces. Posteriorly each external intercostal muscle extends to the tubercle of the rib.

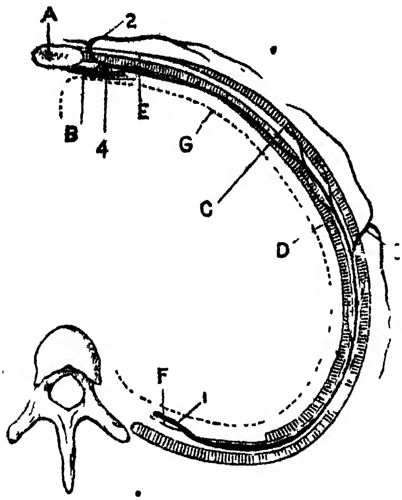
Reflect the external intercostal muscles upwards in some of the intercostal spaces by dividing them along the upper borders of the ribs. The internal intercostal muscles are exposed.

The **Internal Intercostal Muscles** are also eleven in number on each side of the thorax. Each muscle arises from the ridge which forms the upper boundary of the costal groove on the inner surface of a rib and also from the inner lip of the lower border of the corresponding costal cartilage. It is inserted into the inner lip of the upper border of the rib below and its cartilage. The first internal intercostal muscle arises from the lateral part of the under surface of the first costal arch. The muscle fibres are directed downwards and lateralwards in front of the thorax; and downwards and backwards further posteriorly. Anteriorly each muscle extends to the end of the intercostal space but posteriorly it extends up to the angle of the rib beyond which it will be seen to be continued to the vertebral column by a membrane, called the *posterior intercostal membrane.*

Nerve-supply.—The intercostal muscles are supplied by the intercostal nerves.

The **Intercostal Nerves** are the anterior divisions of the thoracic nerves and are eleven in number on each side. At this stage of the dissection they lie concealed on the lower borders of the ribs in the costal grooves and have to be pulled down with forceps for bringing them into view. They lie between the external and internal intercostal muscles on the lateral aspect of the thorax. Mid-way between the vertebral column and the sternum each

intercostal nerve passes through the substance of the internal intercostal muscle and behind the costal cartilage it passes between the pleura and the internal intercostal muscle. Further forwards it crosses in front of the inter-



A. Sternum.

B. Transversus thoracis.

C. External intercostal muscle.

D. Internal intercostal muscle.

E. Anterior intercostal membrane.

F. Posterior intercostal membrane.

G. Parietal pleura.

1. Intercostal nerve.
2. Anterior cutaneous branch.
3. Lateral cutaneous branch.
4. Internal mammary artery.

Fig. 29.– Diagram to illustrate the external and internal intercostal muscles and the anterior and posterior intercostal membranes. (After Cunningham).

nal mammary artery and the transversus thoracis and at the side of the sternum it perforates the internal intercostal muscle, the anterior intercostal membrane and the pectoralis major to become the *anterior cutaneous nerve* of the thorax. The lower six intercostal nerves on leaving the intercostal spaces enter the abdominal wall and their terminations as anterior cutaneous nerves near the linea alba have been described (p. 27).

Branches of the intercostal nerves.—These are (1) muscular and (2) lateral cutaneous. The *muscular branches*

supply the intercostal and subcostal muscles and the transversus thoracis. The *lateral cutaneous branches* are given off from all the intercostal nerves except the first. They pierce the external intercostal muscles and pass between the digitations of the serratus anterior midway between the vertebral column and the sternum.

The **Intercostal Arteries** are eleven in number and run from behind forwards to the intercostal spaces. Of these the upper two are the branches of the superior intercostal artery which is a branch of the costocervical trunk of the subclavian artery. The lower nine are derived from the thoracic aorta. They lie in the costal grooves between the external and internal intercostal muscles above the level of the intercostal nerves. Midway between the vertebral column and the sternum each intercostal artery gives off a branch which descends to the upper border of the rib below. The main artery continues its course along the lower border of the rib above and its branch along the upper border of the rib below. Both of these pass medialwards towards the sternum to anastomose with the two anterior intercostal branches of the internal mammary artery in the upper six intercostal spaces and with those of the musculophrenic artery in the seventh, eighth and ninth spaces. The aortic intercostal arteries of the tenth and eleventh intercostal spaces pass medialwards into the anterior abdominal wall and have been described (p. 21).

Branches.—Each intercostal artery gives off *muscular branches* to the muscles in the intercostal space and a *lateral cutaneous branch* which accompanies the lateral cutaneous nerve.

The *intercostal vein* accompanies the artery and lies above it in the costal groove. Its termination will be seen at a later stage of the dissection.

The *anterior intercostal arteries* are the branches of the

internal mammary artery in the upper six intercostal spaces and they arise from its musculophrenic branch in the succeeding three spaces. There are two arteries in each intercostal space which pass lateralwards along the borders of the ribs and lie at first behind the internal intercostal muscle. Then they pierce this muscle and lie superficial to it and anastomose with the intercostal arteries which are proceeding towards the sternum.

Remove the intercostal muscles. The parietal pleura will be seen lining the inner aspect of the internal intercostal muscles and the costal arches. The internal mammary artery with its companion veins will be seen lying about half an inch lateral to the sternum behind the costal cartilages and in front of the transversus thoracis.

The **Internal Mammary Artery** arises from the first portion of the subclavian artery in the neck. It enters the thorax behind the sternal end of the clavicle and the the first costal cartilage. It then descends vertically about half an inch lateral to the sternum lying upon the pleura in the upper part of its course and upon the transversus thoracis in its lower part. Reaching the sixth intercostal space it divides into two terminal branches, the musculophrenic and the superior epigastric arteries. It is covered in front by the upper six costal cartilages, the intervening internal intercostal muscles and anterior intercostal membranes, and the terminal parts of the intercostal nerves. Two *venæ comitantes* accompany the artery and unite above to form a single trunk which terminates in the innominate vein of its own side.

Four or five *lymph glands* are seen along the course of each internal mammary artery. Their afferent vessels come from the upper part of the anterior abdominal wall and from the anterior wall of the thorax and mamma.

The *branches* of the internal mammary artery are:—

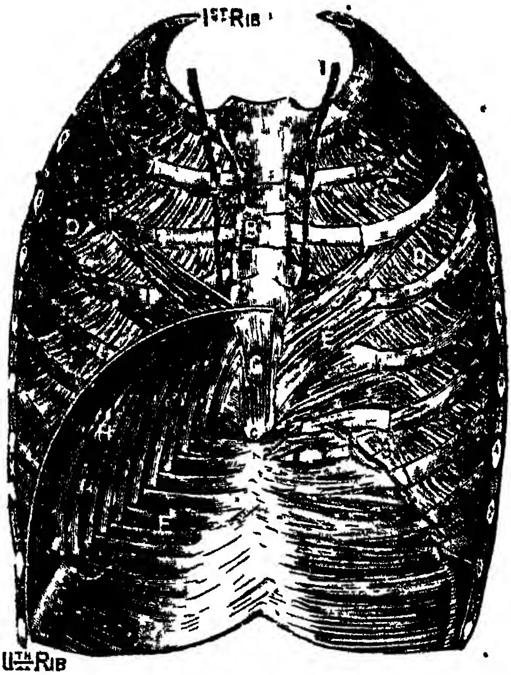


Fig. 30.—Posterior aspect of the anterior wall of the thorax and upper part of the anterior abdominal wall (after Luschka).

A. Manubrium sterni.
B. Gladiolus.
C. Xiphoid process.
D. Internal intercostal muscle.
E. Transversus thoracis.
F. Transversus abdominis.
G. Sternal origin of diaphragm.
H. Costal origin of diaphragm.
1. Internal mammary artery.
2. Superior epigastric artery.
3. Musculo-phrenic artery.

(1) The *pericardiaco phrenic* (comes nervi phrenici) which accompanies the phrenic nerve to the diaphragm and will be seen inside the thorax. (2) The *mediastinal branches* are minute twigs supplying the areolar tissue of the anterior mediastinum and the remains of the thymus

gland (3) The *pericardial branches* are minute twigs supplying the anterior surface of the pericardium. (4) The *sternal branches* supply the transversus thoracis and the back part of the sternum. (5) The *anterior intercostal arteries* are two in each of the upper six intercostal spaces. They pass lateralwards and then anastomose with the intercostal branches of the superior intercostal artery and of the aorta. (6) The *perforating arteries* issue through the upper six intercostal spaces perforating the internal intercostal muscles, the anterior intercostal membranes and the pectoralis major and reach the integument of the chest. In the female the perforating branches of the second, third and fourth spaces are of large size and supply the mammary gland. (7) The *musculophrenic* is the lateral terminal branch of the internal mammary artery. It runs downwards and lateralwards behind the costal cartilages and pierces the diaphragm opposite the eighth costal cartilage and terminates opposite the last intercostal space. It gives off (*a*) *muscular branches* to the diaphragm and (*b*) the *anterior intercostal branches* to the seventh, eighth and ninth intercostal spaces, corresponding to the anterior intercostal branches of the internal mammary artery. (8) The *superior epigastric artery* is the medial terminal branch of the internal mammary. It leaves the thorax by passing along the interval between the sternal and costal origins of the diaphragm. Its distribution inside the sheath of the rectus has been described (p. 31).

The **Transversus Thoracis** (Triangularis sterni) is now partly exposed between the costal cartilages. Its origin from (1) the posterior surfaces of the xiphoid process and the lower third of the gladiolus and (2) the posterior surfaces of the fifth, sixth and seventh costal cartilages near the sternum will be fully seen when the sternum with the costal cartilages is removed. The upper fibres are

oblique being directed upwards and lateralwards while the lower fibres are horizontal and continuous with the fibres of the transversus abdominis. It is inserted into the posterior surfaces and lower borders of the costal cartilages of the second, third, fourth, fifth and sixth ribs. It is supplied by the intercostal nerves.

THE THORACIC CAVITY.

The lungs and the heart are the chief viscera contained in the thoracic cavity. The two lungs occupy the sides of the cavity and each is covered by a serous membrane of its own called the pleura. Each lung is free within the thorax except at its root which consists of certain structures to be examined later on. The heart is situated between the lungs and is enclosed in a membranous bag called the pericardium. The space lying between the two pleural sacs is called the mediastinum and is occupied by the pericardium and other structures which will be described later on.

The student should now proceed to study the pleura. A certain amount of dissection is necesasry to examine the reflections of this membrane. The sternum is to be sawn across (1) along the lower margins of the first pair of costal cartilages and (2) between the sixth and seventh pairs of costal cartilages. The second, third, fourth, fifth and sixth costal cartilages are to be divided near their junction with the ribs. The anterior ends of the ribs are also to be removed by snipping them with the bone pliers as far back as practicable. The pleura lining the ribs and costal cartilages should be gently separated by the fingers. The intervening portion of the sternum with the costal cartilages attached to it should be removed after the pleura has been traced and preserved for the examination of the ligaments. Divide the pleura lining

the thoracic wall at the lateral ends of the costal cartilages by a vertical incision.

The **Pleura** is a delicate serous membrane which invests the lung and is then reflected over the structures contained in the mediastinum and over the inner surface of the parietes of the chest. The portion of the membrane investing the lung is called the pulmonary pleura. The remaining portion is called the parietal pleura. Between the pulmonary and parietal pleura is a space which is called the cavity of the pleura. It is only in diseased conditions that there is a real space between the two layers, otherwise they are in actual contact in the healthy subject containing enough lymph to allow the lung to move freely in the thoracic cavity. Each pleura forms a completely closed sac, occupying its own half of the thorax and does not communicate with that on the opposite side. The two pleural sacs do not come into contact with each other except for a short distance behind the upper end of the gladiolus.

Parietal Pleura.—The dissector should now trace the parietal pleura and define its limits. The parietal pleura is subdivided into four portions, viz., the costal pleura, the diaphragmatic pleura, the cervical pleura and the mediastinal pleura.

Costal Pleura.—Its anterior limit may be ascertained by introducing the fingers through the incision in the pleural cavity and pushing them towards the sternum. *Anteriorly* the pleural sacs extend from behind the sterno-clavicular articulation to the mid point of the angulus sterni. Thence the anterior limit of the right pleural sac descends vertically to the posterior surface of the xiphoid process. The left pleura descends vertically behind the sternum from the angulus sterni to the level of the fourth costal cartilage. Thence it diverges from the right pleura to reach the left margin of the sternum

along which it descends to the level of the sixth costal cartilage at its junction with the sternum. Traced *laterally* from the anterior limit behind the sternum the pleura lines the inner aspects of the ribs and their cartilages and the intercostal muscles till it reaches the heads of the ribs. From here it is reflected on to the sides of the bodies of the thoracic vertebræ. Thence it is reflected forwards forming part of the mediastinal pleura. Traced *above* it lines the inner margin of the first rib and is prolonged into the neck as the cervical pleura. Traced *below* it is reflected on the upper surface of the diaphragm forming the diaphragmatic pleura. The *lower limit* of the costal pleura where it is reflected on to the diaphragm differs on the two sides. The *right* pleura passes from behind the xiphoid process downwards and lateralwards behind the anterior extremity of the eighth rib and reaches the upper border of the tenth rib in the midaxillary line. Thence it passes backwards and medialwards across the eleventh rib and reaches the vertebral column covering the head of the twelfth rib. The *left* pleura passes from the junction of the sternum with the left

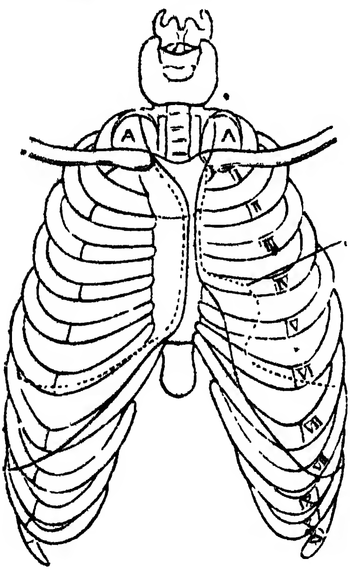


Fig. 31.—Front view of the two pleural sacs. The lines of pleural reflection are indicated by black lines. The outlines of the lungs are exhibited by dotted lines (from Gegenbaur).

A. Apex pulmonis.
B. Cardiac notch.

sixth costal cartilage downwards and lateralwards and lines the inner surface of the seventh costal cartilage. Then it proceeds across the inner surfaces of the eighth, ninth and tenth ribs reaching the lower border of the tenth rib in the midaxillary line. Thence it passes backwards and medialwards to the vertebral column covering the head of the twelfth rib and descending a little lower down than on the right side to midway between the head of the twelfth rib and the transverse process of the first lumbar vertebra.

The **Diaphragmatic Pleura** lines the upper surface of the diaphragm and is continuous with the costal pleura at the line of its lower limit. The lower margin of the lungs does not reach the line of junction of the costal and diaphragmatic pleura. Hence at that angle a space is left unoccupied by the lower margin of the lung. This space is called the *costophrenic sinus.*

The **Cervical Pleura** (cupola or dome of the pleura) is the continuation of the costal pleura above the level of the first rib. It projects into the neck for about one to two inches and is strengthened by an expansion of the deep fascia of the neck (*Sibson's fascia*).

The **Mediastinal Pleura** is the portion of the pleura extending from the back of the sternum to the vertebral column. It forms the lateral boundary of the mediastinum and is divisible into two parts at the level of the root of the lung, an anterior part lying in front of the root of the lung and a posterior part lying behind it. The costal pleura from the back of the sternum is reflected on the surface of the pericardium as the anterior part of the mediastinal pleura, and covering the anterior surface of the root of the lung is continuous with the pulmonary pleura on the surface on the lung. The pulmonary pleura from the posterior surface of the root of the lung is again reflected backwards on the pericardium as the posterior

part of the mediastinal pleura and thence further backwards on the vertebral column to be continuous with the costal pleura. The *pulmonary ligament* (ligamentum latum pulmonis) is a triangular duplicated fold of the mediastinal pleura extending from the side of the pericardium to the mediastinal surface of the lung. Its apex is attached to the lower border of the root of the lung and its base is free towards the diaphragm. Behind the sternum the anterior margins of the lungs do not extend up to the line of junction of the costal and mediastinal pleuræ. This angular space of the pleural sac unoccupied by the anterior margin of the lung is called the *costomediastinal sinus*.

The **Pulmonary Pleura** invests the surfaces of the lung and dips between the fissures on them. After covering the anterior and posterior surfaces of the roots of the lungs it is continuous with the mediastinal pleura.

The **Mediastinum** is the space between the two pleural sacs containing all the viscera of the thorax except the lungs. The whole of this interpleural space is subdivided into four portions from the relations they bear to the pericardium (Fig. 32). The space marked I, situated between the sternum in front and the pericardium behind, represents the anterior mediastinum; the space II, which contains the pericardium is the middle mediastinum; and the space III, situated behind the pericardium, is the posterior mediastinum In addition to these three spaces there is a fourth space not shown in the figure, as it lies on a higher plane being placed above the pericardium—this is the superior mediastinum.

The **Anterior Mediastinum** is that portion of interpleural space which is bounded in front by the posterior surface of the sternum and behind by the pericardium. While studying the reflections of the pleura, the dissector has noticed that the two pleural sacs come into contact

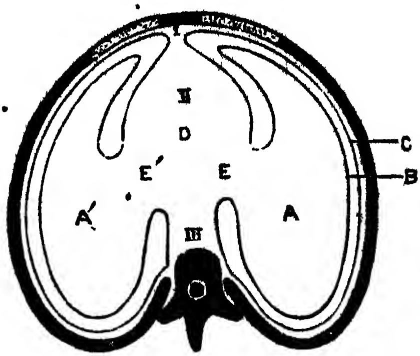


Fig. 82.—Diagram showing the two pleural sacs as seen in transverse section. The mediastinal spaces are also exhibited.

A. Right lung.
A1. Left lung.
B. Pulmonary pleura.
C. Parietal pleura.
D. Pericardium.
E. Right pulmonary root.
E1. Left pulmonary root.
I. Anterior mediastinum.
II Middle mediastinum
III. Posterior mediastinum.

in the upper part of this mediastinal space. As a result of this there is practically no space in the upper part of the anterior mediastinum. The only space that can be demonstrated in the anterior mediastinum is below the sternal extremities of the fourth pair of costal cartilages where the two pleural sacs separate from each other. The space contains some areolar tissue, two or three lymph glands, and the mediastinal branches of the internal mammary artery. The lymph glands receive the lymphatic vessels from the diaphragm and the upper surface of the liver.

The **Middle Mediastinum** is the largest of the mediastinal spaces. It contains the pericardium enclosing the heart, the ascending aorta, the lower portion of the superior vena cava with the termination of the azygos vein, the pulmonary arteries and veins, the phrenic nerves with the companion pericardiaco-phrenic arteries, the

bifurcation of the trachea, and some bronchial lymph glands.

The **Posterior Mediastinum** lies behind the pericardium and in front of the thoracic vertebræ below the level of the fourth thoracic vertebra. Laterally it is bounded by the mediastinal pleura. The contents of this space will be studied at a later stage of the dissection.

The **Superior Mediastinum** comprises that part of the interpleural space which lies above the upper level of the pericardium. (It is bounded in front by the manubrium sterni, behind by the bodies of the upper four thoracic vertebræ, laterally by the mediastinal pleura, and below by an oblique plane extending from the lower border of the manubrium sterni to the lower border of the body of the fourth thoracic vertebra.[1] The dissection of the structures at the root of the neck must have been sufficiently advanced by this time so that the student has got an opportunity of examining most of the contents of this space. These are: (1) The origins of the sterno-hyoid and sterno-thyreoid muscles as also the lower portions of the longus colli muscles; (2) the transverse portion of the arch of the aorta with its three large branches, the innominate, the left common carotid, and the left subclavian arteries; (3) the upper portion of the superior vena cava and the right and left innominate veins; (4) the vagus, phrenic, cardiac and left recurrent nerves; (5) the trachea, œsophagus, and thoracic duct; and (6) the remains of the thymus gland.

The dissector should now examine the course of the phrenic nerve through the thorax. The mediastinal pleura is to be separated from the pericardium when the nerve will be exposed.

The **Phrenic Nerve** arises in the neck by three roots from the third, fourth and fifth cervical nerves; the root from the fourth being the largest. It descends on the

scalenus anterior muscle, passes behind the subclavian vein and enters the superior mediastinum by crossing the internal mammary artery near the origin of the vessel. It then runs downwards in the middle mediastinum, lying by the side of the pericardium and in front of the root of the lung. It then reaches the upper surface of the diaphragm where it breaks up into branches which pierce the muscle and are distributed on its inferior surface.

It should be noticed that the phrenic nerves of the two sides differ from each other in their course, relations and length. The *right phrenic nerve* is placed more deeply, is more vertical in its course and lies lateral to the right innominate vein and superior vena cava. The *left phrenic nerve* lies between the left common carotid and the left subclavian arteries behind the left innominate vein and crosses the left side of the arch of the aorta. It is longer than the right phrenic nerve, due to its curving over the apex of the heart which projects to the left and also due to the diaphragm being on a lower level on the left side than on the right.

Besides supplying branches chiefly to the diaphragm, the phrenic nerve also gives fine filaments to the pericardium and pleura during its course through the thorax. The pericardiacophrenic branch of the internal mammary artery accompanies the phrenic nerve.

The **Lungs** are placed, each in its own half of the thoracic cavity, separated from each other by the pericardium containing the heart. There is a good deal of difference between a healthy lung in a living subject and the lung that is commonly seen in the dissecting-room. The dissector usually finds that the lung is very much collapsed and hence does not accurately fit into the cavity containing it. Frequently the lung does not remain free in the thoracic cavity owing to old inflammatory adhesions between the pulmonary and parietal pleuræ. Moreover

the lung does not bear any indentations of the structures with which it is in contact unless it is hardened in situ. A healthy lung is of a mottled slate colour and is conical in form. It presents for examination an apex, a base, two surfaces and three borders.

Apex.—The apex is rounded and projects into the root of the neck for about one inch to one inch and a half above the level of the first rib. On its anterior aspect an indentation for the subclavian artery is seen.

Base.—The base is concave and rests on the diaphragm. The base of the right lung is more deeply concave than that of the left. The relations of the bases of the lungs with some of the abdominal viscera are important, being separated from them by the diaphragm alone: thus, the base of the right lung is in relation with the right lobe of the liver, and the base of the left lung with the left lobe of the liver, the stomach and the spleen.

Surfaces.—The *costal surface* is convex and adapted to the concavity of the costal arches and the intercostal spaces. The *medial* or *mediastinal surface* is concave, specially in front to accommodate the pericardium containing the heart. The concavity in the medial surface of the left lung is more marked than on the right, due to a greater projection of the heart on the left side. A little above and behind the middle of this surface is a longitudinal cleft, the *hilum pulmonis*, through which the structures forming the root of the lung pass.

Impressions.—If the lungs are hardened in situ certain impressions are seen on their mediastinal surfaces produced by the structures against which they lie. Thus in the *right lung* (1) a narrow arched groove above the hilum produced by the azygos vein is seen. (2, 3) Two vertical grooves run upwards above the former to a little below the apex of the lung; one of them lies in front and the other behind. The lower part of the anterior groove

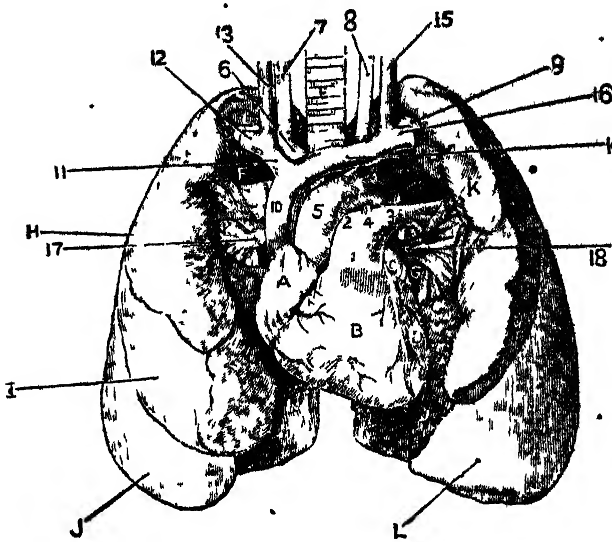


Fig. 33.—The heart and lungs (after Wilson).

A. Right atrium.
B. Right ventricle.
C. Left auricula
D. Left ventricle.
E. Trachea
F. Right bronchus.
G. Left bronchus.
H. Upper lobe of right lung.
I. Middle lobe.
J. Lower lobe.
K. Upper lobe of left lung.
L. Lower lobe.
1. Pulmonary artery.
2. Right pulmonary artery.
3. Left pulmonary artery.
4. Ligamentum arteriosum.
5. Arch of the aorta.
6. Innominate artery.
7. Right common carotid artery.
8. Left common carotid artery.
9. Left subclavian artery.
10. Superior vena cava.
11. Right innominate vein.
12. Right subclavian vein.
13. Right internal jugular vein.
14. Left innominate vein.
15. Left internal jugular vein.
16. Left subclavian vein.
17. } Pulmonary veins.
18. }

lies against the superior vena cava and the upper part of it against the right innominate vein. The posterior groove is produced by the innominate artery. (4) A third vertical groove is situated behind the hilum and the pulmonary ligament and is produced by the œsophagus. (5) A short groove for the inferoir vena cava is situated

in front and to the right of the œsophageal groove. On the mediastinal surface of the *left lung* are seen (1) a broad arched groove above the hilum caused by the arch of the aorta ; (2, 3) two vertical grooves above the former, one of them lying in front and the other behind. The groove in front is caused by the left innominate vein and the groove behind is for the left subclavian artery. (4) A third vertical groove lies behind the hilum and the pulmonary ligament for the descending aorta.

Borders.—The *anterior border* is very thin and sharp and projects towards the costomediastinal sinus. The anterior border of the left lung presents in its lower part a notch, the *cardiac notch* where the pericardium is exposed. The *posterior border* is thick and rounded and fits into the concavity on either side of the vertebral column. The *inferior border* or circumference of the base is prolonged posteriorly and projected towards the costophrenic sinus ; medially it is rounded.

Fissures and Lobes of the Lungs.—Each lung is divided into an *upper* and a *lower lobe* by a long and deep oblique *fissure* which penetrates nearly to the hilum. It begins at the upper and back part of the hilum and passes upwards and backwards to the posterior border of the lung a little below the apex. Then it crosses the costal surface by passing downwards and forwards and cuts the inferior border of the lung a little behind the anterior border. Thence it passes to the lower part of the hilum along the medial surface of the lung. The upper lobe of the right lung is further subdivided by a *transverse fissure* which begins at the posterior border of the lung where it is cut by the oblique fissure and runs horizontally forwards to the anterior border of the organ at the level of the fourth costal cartilage. This fissure marks off from the lower part of the upper lobe a triangular portion called the *middle lobe*.

The following points of difference between the right and the left lung should be noted. (1) The right lung is shorter owing to its base being pushed upwards by the right lobe of the liver. (2) It is wider than the left owing to the heart projecting more to the left side. (3) The anterior border of the right lung is straight while that of the left lung presents a notch, the cardiac notch. (4) The cardiac impression on the mediastinal surface of the left lung is deeper than that on the right lung. (5) The base of the right lung is more deeply concave than that of the left. (6) There are three lobes and two fissures in the right lung but two lobes and one fissure in the left. (7) The relation of the structures forming the root of the lung differs on the two sides. (8) Differences are presented on the two lungs caused by the impressions on their medial surfaces.

Root of the Lung.—This term is employed to denote a collection of structures which enter and leave the hilum of the lung covered by pleura. On both sides the phrenic nerve lies in front of the root and the vagus nerve behind it. The root of the right lung is placed behind the superior vena cava and below the azygos vein, while that of the left lung lies in front of the descending aorta and below the arch of the aorta.

The dissector should now examine the *constituent parts of the root of the lung*. These are the bronchial tube, the pulmonary artery, the two pulmonary veins, one or two small bronchial arteries and veins, the pulmonary nerves, lymphatic vessels, bronchial lymph glands and areolar tissue all of which are enclosed by pleura.

Remove the pleura covering the root of the lung taking care of the nerve filaments which form the anterior and posterior pulmonary plexuses. The anterior pulmonary plexus will be seen in front of the root, while to display the posterior pulmonary plexus, the lung should be thrown

forwards and held with chain-hooks. The bronchial artery is to be searched for behind the bronchial tube. The bronchus, the pulmonary artery and the pulmonary veins are to be isolated from each other.

The Bronchial Arteries are the nutrient vessels of the lungs. The *right bronchial artery* arises either from the first aortic intercostal artery or conjointly with the left bronchial artery from the front of the descending aorta. The *left bronchial arteries* (usually two in number) arise from the descending aorta. Each vessel runs behind the corresponding bronchus and accompanies it to be distributed to the bronchial tubes, the cellular tissue of the lung and the bronchial lymph glands. The *bronchial veins* formed by minute twigs corresponding to the branches of the bronchial arteries open on the right side into the azygos vein and on the left side into the left superior intercostal vein or into the accessory hemiazygos vein.

Pulmonary Plexuses of Nerves.—The *anterior pulmonary plexus* is formed in front of the root of the lung by two or three anterior bronchial branches derived from the vagus, joining with filaments from the sympathetic. It also receives twigs from the cardiac plexuses. The *posterior pulmonary plexus* is found behind the root of the lung and is formed by a large number of posterior bronchial branches derived from the vagus and joining with filaments from the sympathetic ganglia. From this plexus branches are distributed to the bronchial tubes and bronchial blood vessels.

The other structures of the root of the lung will be described later on.

The disposition of the structures constituting the root of the lung from before backwards is the same on both sides, viz., the pulmonary veins anteriorly, the pulmonary artery in the middle and the bronchus posteriorly. From above downwards the arrangement differs in the two

B A.V.

sides. On the right side are seen—1st the bronchus (eparterial), 2nd the pulmonary artery, 3rd the bronchus (hyparterial), 4th the pulmonary veins; while on the left side—1st the pulmonary artery, 2nd the bronchus, 3rd the pulmonary veins.

Now study the pericardium.

The **Pericardium** is a conical fibroserous bag containing the heart and the roots of the great vessels. *In front* of it is the anterior mediastinum. It is partly covered in front by the anterior margins of the lungs and the pleuræ. *Behind* it, is the posterior mediastinum with its contents. *Laterally* it lies in contact with the mediastinal pleuræ, and the phrenic nerve with the pericardiacophrenic artery runs down between the pericardium and pleura on either side. Its *base* is attached mainly to the central tendon of the diaphragm. Its *apex* is prolonged over the great vessels connected with the base of the heart.

Structure. The pericardium consists of two layers, an external fibrous and an internal serous layer. The *fibrous layer* is attached below to the central tendon of the diaphragm encroaching upon its left muscular part. *Above* it is prolonged on the great vessels forming tubular sheaths for them except for the inferior vena cava. In front it is attached to the sternum by two fibrous bands called the *superior* and *inferior sternopericardial ligaments.* The superior one passes to the back part of the manubrium and the inferior one to the back part of the xiphoid process. The *serous layer* forms a shut sac. To expose it the pericardium is to be opened by two incisions, a longitudinal from the aorta to the diaphragm and a transverse, from one root of the lung to the other. The serous layer is divisible into two portions, a parietal and a visceral. The *parietal portion* lines the inner surface of the fibrous layer and is reflected over the heart to form the visceral

portion or *epicardium*. The great vessels connected with the heart receive coverings from the visceral portion to the extent of about an inch and a half. But the ascending aorta and the pulmonary artery are enclosed in a single complete sheath, so that the finger can be easily passed into the space behind the two vessels. This space is called the *transverse sinus of the pericardium.*

Between the left pulmonary artery and the left upper pulmonary vein a triangular fold of the serous layer exists. This is known as the *ligament of the left vena cava* (Vestigeal fold of Marshall). It contains the fibrous remains of the lower part of the left superior vena cava of the embryo.

The **Superficial Cardiac Plexus** is situated in the concavity of the arch of the aorta and above the bifurcation of the pulmonary artery. It is formed by the superior cardiac branch of the left sympathetic and the inferior cardiac branch of the left vagus nerve in the neck. Trace these two cardiac nerves as they cross the left part of the aortic arch to reach its concavity. A small ganglion, the *ganglion of Wrisburg,* is usually found at the point of junction of these nerves. Filaments from the deep cardiac plexus lying behind the arch of the aorta also join the superficial plexus. The superficial cardiac plexus distributes branches to the anterior coronary and left anterior pulmonary plexuses.

The study of the heart should now engage the attention of the dissector. The organ should not be removed from the thoracic cavity but all examinations of its exterior and interior should be made *in situ.*

The Heart is a hollow muscular organ which receives and propels blood.

I. *Position.*—The heart lies obliquely in the middle mediastinum between the two lungs inside the pericardium. It projects more into the left side than into the right,

about one third of the organ lying to the right, and about two thirds of it to the left of the mesial plane.

II. **Shape and Size.**—The heart has the shape of an irregular cone. A normal heart measures five inches in length, three and a half inches in breadth, and two and a half inches in thickness.

III. **Component Parts.**—There are grooves on the outer surface of the heart which indicate the internal subdivision of the organ into four cavities. Thus a transverse groove, called the *coronary sulcus* (auriculoventricular groove) runs transversly showing the line of separation of the upper two chambers called the atria from the lower two chambers called the ventricles. The groove is deficient in front being crossed by the root of the pulmonary artery. Another groove, the *interatrial groove* (interauricular groove), which runs vertically upwards from the preceding groove on the posterior aspect of the atrial portion of the heart, shows the line of separation between the right and left atria. A vertical groove called the *anterior longitudinal sulcus* (anterior interventricular groove) passes in front of the lower or ventricular portion of the heart near its left border. It ends below at the inferior border of the heart close to the apex where a notch is seen, called the *incisura apicis cordis*. This sulcus shows the line of subdivision of the ventricular portion into a right and a left ventricle anteriorly. Another vertical groove called the *posterior longitudinal sulcus* (posterior interventricular groove) extends from the coronary sulcus to the incisura apicis cordis on the posterior surface of the ventricle close to the right border of the heart. This sulcus indicates the line of separation between the right and left ventricles posteriorly.

IV. **General Description.**—The heart presents for examination a base, an apex, two surfaces and three borders. The *base* is the attached end of the organ, and

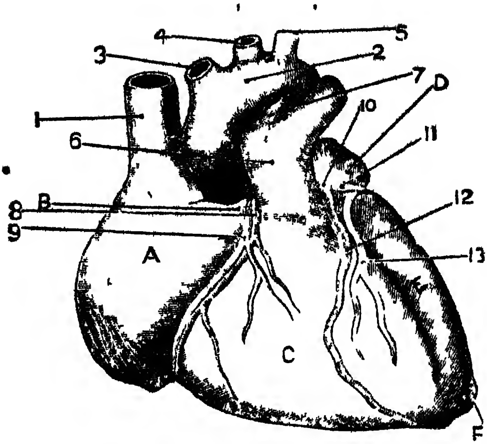


Fig. 84.—Anterior aspect of the heart (after Gegenbaur).

A. Right atrium.
B. Right auricula.
C. Right ventricle.
D. Left auricula.
E. Left ventricle.
F. Apex of the heart.
1. Superior vena cava.
2. Arch of the aorta.
3. Innominate artery.
4. Left common carotid artery.
5. Left subclavian artery.
6. Pulmonary artery.
7. Ligamentum arteriosum.
8. Right coronary artery.
9. Small cardiac vein.
10. Left coronary artery.
11. Its circumflex branch.
12. Its anterior descending branch.
13. Great cardiac vein.

is formed by the atria. It is directed upwards, backwards and to the right. The *apex* is somewhat rounded and is formed entirely by the left ventricle. It is directed downwards, forwards and to the left and lies against the left fifth intercostal space three and a half inches to the left of the midsternal line. The *anterior* or *sternocostal surface* is convex and is formed chiefly by the right atrium and the right ventricle. On it are seen the coronary sulcus and the anterior longitudinal sulcus. The *posterior* or *diaphragmatic surface* is flattened and is formed chiefly by the left ventricle. It lies on the diaphragm and

on it are seen the posterior part of the coronary sulcus and the posterior longitudinal sulcus. The *right border* is almost vertical. It is rounded and formed by the right atrium. The *left border* is thick and rounded and formed by the left ventricle. The *inferior border* is almost horizontal. It is thin and formed by the right ventricle.

V. **Arteries.**—The coronary arteries supply the heart with blood for its nutrition, and are two in number, a right and a left. The **right coronary artery** arises from the anterior aspect of the root of the ascending aorta in the anterior aortic sinus. It passes forwards between the root of the pulmonary artery and the right auricula. It then turns to the right along the coronary sulcus, winds round the right margin of the heart and passes towards the left along the coronary sulcus on the posterior surface of the heart. Reaching the upper end of the posterior longitudinal sulcus it divides into a small transverse

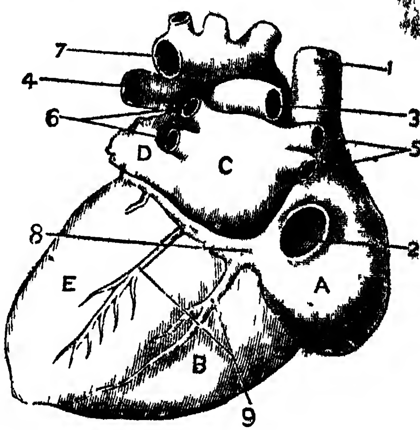


Fig. 35.—Posterior aspect of the heart (after Gegenbaur).

A Right atrium.
B. Right ventricle.
C. Left atrium.
D. Left auricula.
E. Left ventricle.
1. Superior vena cava.
2. Inferior vena cava.
3. Right pulmonary artery.
4. Left pulmonary artery.
5. Right pulmonary veins.
6. Left pulmonary veins.
7. Arch of the aorta.
8. Coronary sinus.
9. Posterior cardiac veins.

branch and a posterior descending branch. The *transverse branch* continues the course of the main artery along the coronary sulcus and anastomoses with the circumflex branch of the left coronary artery. The *posterior descending branch* descends along the posterior longitudinal sulcus towards the apex of the heart. While at the right margin of the heart the right coronary artery gives off a *marginal branch* which runs along the inferior border of the heart towards the apex and supplies branches to both surfaces of the right ventricle. The **left coronary artery** is larger than the right and arises from the left and posterior part of the root of the ascending aorta in the left posterior aortic sinus. It passes to the left behind the pulmonary artery and then between the pulmonary artery and the left auricula and divides into two branches. One of these the *circumflex branch* runs to the left along the coronary sulcus, curves round the left margin of the heart to the posterior surface of the organ and anastomoses with the transverse branch of the right coronary artery; while the other, the *anterior descending branch*, runs downwards along the anterior longitudinal sulcus to the apex of the heart anastomosing with the posterior descending branch of the right coronary artery.

VI. **Veins.**—The veins which return the blood from the substance of the heart are :—(1) The *coronary sinus* which is a dilated venous channel situated in the coronary sulcus on the posterior surface of the heart between the left atrium and the left ventricle. It is about an inch in length and opens by its right end into the right atrium of the heart. The great cardiac vein opens into it at its left end. (2) The *great cardiac vein* begins at the apex of the heart. It ascends along the anterior longitudinal sulcus and turns to the left in the coronary sulcus. It then curves round the left margin of the heart to open into the left end of the coronary sinus. In its course

it receives several small veins including the *left marginal vein* which ascends along the left margin of the heart. (3) The *posterior cardiac veins* run upwards along the posterior surface of the ventricle and open into the coronary sinus. One of these ascends along the posterior longitudinal sulcus and is called the *middle cardiac vein.* (4) The *anterior cardiac veins* are usually three or four in number and run along the anterior surface of the right ventricle. They open directly into the lower part of the atrium. (5) The *small cardiac vein* (right coronary vein) lies in the coronary sulcus between the right atrium and ventricle, curves round the right margin of the heart and opens into the right extremity of the coronary sinus. It receives the *right marginal vein* which runs along the inferior border of the heart. (6) The *oblique vein of the left atrium* (oblique vein of Marshall) begins at the ligament of the left superior vena cava and terminates in the left extremity of the coronary sinus by passing along the posterior aspect of the left atrium. (7) The *venæ cordis minimæ* or *smallest cardiac veins* (venæ Thebesii) are minute veins which transmit the blood from the muscular substance of the heart directly into the right atrium. They are not seen on the surface of the heart and their openings into the right atrium will be seen when that chamber is opened.

VII. **Nerves.**—The nerve supply of the heart is derived from the coronary plexuses which are two in number, a right and a left. The *right coronary plexus* accompanies the right coronary artery and is derived from the superficial cardiac plexus and also from the deep cardiac plexus and is situated behind the arch of the aorta. The *left coronary plexus* accompanies the left coronary artery and is derived from the deep cardiac plexus only. Minute ganglia are found in these plexuses. Filaments from these plexuses terminate in the muscle fibres of the heart.

VIII. Chambers of the Heart.—The heart consists of four chambers, viz., right and left atria, and right and left ventricles.

Open the right atrium by an incision from the point of entrance of the superior vena cava to that of the inferior vena cava along the right margin of the atrium. From the upper end of this incision carry the knife to the tip of the auricula. The dissector should wash away all blood and clot from the cavity.

The **Right Atrium** (Right auricle) consists of two parts, the sinus venosus and the auricula. The sinus venosus is the main chamber between the superior and inferior venæ cavæ. The auricula (Auricular appendix) is the ear-shaped projection which is directed forwards and to the left overlapping the root of the aorta. A groove

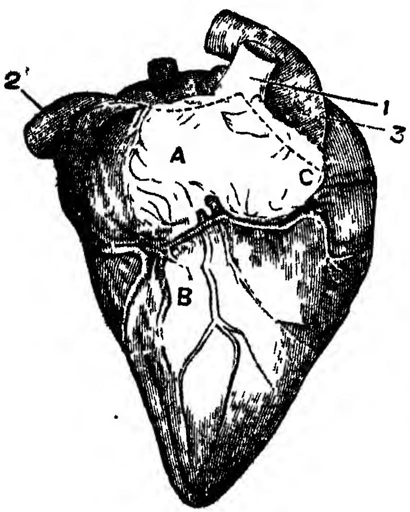


Fig. 36.—Diagram showing how the right atrium should be opened. The dotted lines indicate the direction of the incisions.

A. Right atrium.
B. Right ventricle.
C. Right auricula.
1. Superior vena cava.
2. Inferior vena cava.
3. Aorta.

called the *sulcus terminalis* extends from the front of the superior vena cava to the front of the inferior vena cava and indicates externally the line of separation between the sinus venosus and the auricula.

In the interior of the right atrium the following parts are to be examined :—The orifices of (1) the superior vena cava, (2) the inferior vena cava, (3) the coronary sinus, and (4) the anterior and smallest cardiac veins ; (5) the right atrioventricular orifice, (6) the valve of the inferior vena cava, (7) the valve of the coronary sinus, (8) the fossa ovalis, (9) the limbus fossa ovalis, (10) the musculi pectinati and the crista terminalis, and (11) the intervenous tubercle.

The *orifice of the superior vena cava* is situated at the upper and back part of the right atrium and is directed towards the right atrioventricular opening. It is not guarded by any valve. The *orifice of the inferior vena cava* is placed at the lower part of the right atrium and is directed towards the interatrial septum. It is guarded by a valve. The *orifice of the coronary sinus* is situated between the opening of the inferior vena cava and the right atrioventricular opening. It is guarded by a valve. The *orifices of the anterior cardiac veins* and *smallest cardiac veins* (Venæ cordis minimæ) are the minute openings seen in the interior of the atrium. The *right atrioventricular orifice* is the opening by which the right atrium communicates with the right ventricle. It admits the tips of three fingers and is guarded by a valve.

The *valve of the inferior vena cava* (Eustachian valve) is a semilunar fold of the lining membrane of the heart called the endocardium. Its convex margin is attached to the margin of the orifice and its concave margin is free. Its left end is attached to the ridge in the interatrial septum called the limbus fossa ovalis. Its right end is lost in the wall of the atrium. This valve may be cribriform or altogether absent.

The *valve of the coronary sinus* (Thebesian valve) is a crescentic fold of endocardium guarding the opening of the coronary sinus.

The right atrium is separated from the left atrium by a septum called the *interatrial septum.* Upon this partition, above the opening of the inferior vena cava is seen an oval depression called the *fossa ovalis* bounded

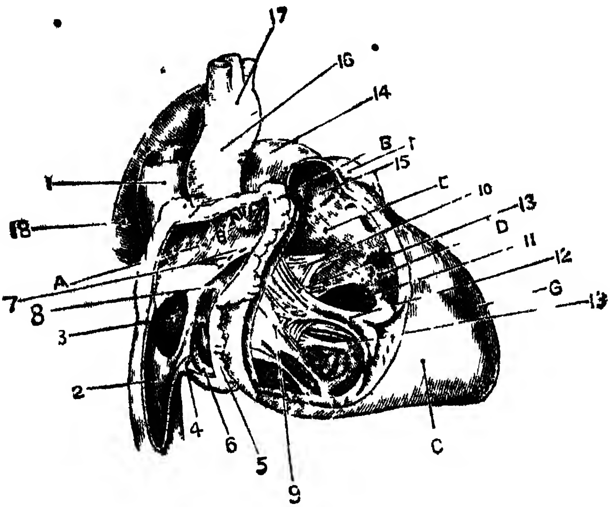


Fig. 37.—The interior of the right atrium and right ventricle (after Wilson).

A. Cavity of right atrium.
B. Auricula.
B1. Musculi pectinati.
C. Right ventricle.
D. Cavity of right ventricle.
E. Conus arteriosus.
F. Apex of left auricula.
G. Left ventricle.
1. Superior vena cava.
2. Inferior vena cava.
3. Fossa ovalis.
4. Valve of the inferior vena cava.
5. Opening of the coronary sinus.
6. Coronary valve.
7. Orifices of venæ cordis minimæ.
8. Commencement of auriculo ventricular opening.
9. Tricuspid valve.
10. Medial cusp.
11. Trabeculæ carneæ.
12. One of the musculi papillares.
13. Chordæ tendineæ.
14. Pulmonary artery.
15. Semilunar valves.
16. Ascending aorta.
17. Arch of the aorta.
18. Descending aorta.

above and at the sides by a raised margin. [This fossa is the remains of the *foramen ovale* of the fœtus through

which the blood passed before birth from the right into the left atrium. The *limbus fossa ovalis* (Annulus ovalis) is the prominent margin which bounds the fossa ovalis above and at the sides.

The *musculi pectinati* are muscular elevations, so named from their resemblance to the teeth of a comb. These are seen in the auricula and in the adjacent anterior wall of the atrium. They terminate in a smooth ridge called the *crista terminalis*, which corresponds in position to the sulcus terminalis seen on the outer surface of the atrium.

The *intervenous tubercle* (Tubercle of Lower) is a small elevation on the posterior wall of atrium below the orifice of the superior vena cava.

The right atrium receives the venous blood returned chiefly by the superior and inferior venæ cavæ. The blood then flows into the right ventricle through the right atrioventricular opening. Note that the wall of the right atrium is thin and its capacity is about two ounces and a half.

The right ventricle should now be opened. A triangular flap is to be raised from its anterior wall by making two incisions: (1) from the root of the pulmonary artery downwards towards the incisura cordis at the inferior border of the heart, a little to the right of the anterior longitudinal sulcus; (2) another incision from the upper end of the first incision carried towards the right a little below the coronary sulcus, terminating at the right end of the inferior border (Fig. 38). The cavity should be washed clean of all blood and clots.

The **Right Ventricle** is triangular in form. Its *anterior wall* forms the greater part of the anterior surface of the heart. Its *posterior wall* is formed by the septum which separates it from the left ventricle, called the *interventricular septum*. This septum bulges into the cavity of the right ventricle. Its *base* is directed upwards and to the

right. At its upper and left part is a conical pouch, called the *conus arteriosus*, which, leads to the orifice of the pulmonary artery. Its *apex* looks downwards towards the apex of the heart. Its wall is thicker than that of the right atrium. The following parts are to be studied in the interior of the right ventricle:—(1) Right atrioventricular orifice, (2) pulmonary orifice, (3) tricuspid valve, (4) pulmonary semilunar valves, (5) trabeculae carneae, (6) chordae tendineae.

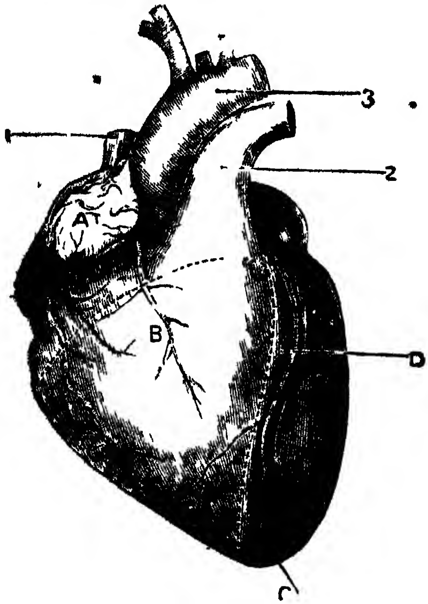


Fig. 38.- Diagram showing how the right ventricle should be opened. The lines of incisions are indicated by the dotted lines (after Cunningham).

A Right atrium.
B. Right ventricle.
C Apex of the heart
D. Anterior longitudinal sulcus in which are seen coronary artery and great cardiac vein.
1. Superior vena cava.
2 Pulmonary artery.
3. Aorta.

The *right atrioventricular orifice* allows the passage of blood from the right atrium into the right ventricle. It is surrounded by a fibrous ring to which is attached the tricuspid valve. The *pulmonary orifice* is situated at the summit of the conus arteriosus and allows the passage of blood from the right ventricle into the lungs through

the pulmonary artery for oxygenation. It is guarded by the pulmonary semilunar valves.

The *tricuspid valve* is formed by three triangular segments or cusps, which prevent regurgitation of the blood into the right atrium during the contraction of the right ventricle. Like all the valves of the heart, it is formed by two layers of the lining membrane, the endocardium, between which is enclosed a very thin layer of fibrous tissue. The three segments or cusps (anterior, posterior and medial) are united by their bases and are fixed to a fibrous ring surrounding the atrioventricular orifice, while their apices hang down into the ventricular cavity. The chordæ rendineæ are attached to their apices. adjacent margins and ventricular surfaces. The *anterior cusp* is situated between the atrial opening and the conus arteriosus; the *posterior cusp* lies against the wall of the ventricle near the inferior margin of the heart: and the *medial cusp* (septal cusp) lies against the interventriular septum.

The *pulmonary semilunar valves* are three in number of which two are placed anteriorly and one posteriorly. They are attached by their convex margins to the orifice of the pulmonary artery, while their concave margins are free and directed upwards and present in the centre of each a thickened nodule, the *nodulus of the valve* (corpus Arantii). The fibrous tissue is spread out in each cusp between the two layers of the endocardium throughout its whole extent except along two narrow semilunar areas, one on either side of the central nodule. These semilunar areas of the cusps are called the *lunulæ* which are very thin and consist only of two layers of endocardium. Between the cusps and the wall of the pulmonary artery are three pouches (Sinuses of Valsalva).

The inner surface of the right ventricle is smooth in the conus arteriosus but its remaining part presents numerous muscular projections of various length and

thickness. These are called *trabeculæ carneæ* (Columnæ carneæ) and are of three kinds. The first set forms *ridges* on the ventricular wall being attached to it by their whole length. The second set forms *bridges* being attached to the ventricular wall by their two extremities, the intermediate portion being free. One fleshy band of this group, called the *moderator band*, is seen to be attached by one extremity to the interventricular septum and by the other to the base of the anterior papillary muscle. It prevents over-distension of the cavity. The third set, called the *musculi papillares*, is of considerable size being fixed at one end to the ventricular wall while the other end gives attachment to several fine tendinous cords, the *chordæ tendineæ*. The papillary muscles are two to four in number. The anterior one is the larger and is attached by its base to the anterior wall of the ventricle. From its apex the chordæ tendineæ pass to the anterior and posterior cusps of the tricuspid valve. The posterior papillary muscles, two or three in number, are fixed by their bases to the interventricular septum and the chordæ tendineæ pass from their apices to the posterior and medial cusps of the tricuspid valve.

In order to open the left atrium, the heart should be drawn well over to the right side, then an incision should be made on the posterior surface of the atrium from the pulmonary veins of the left side to those of the right side, and another from the middle of the first incision to the tip of the auricula (Fig. 39).

The **Left Atrium** is smaller than the right. It is concealed by the aorta and the pulmonary artery. Like the right atrium it consists of a main cavity and an auricula. The latter is longer and more curved and projects to the right overlapping the root of the pulmonary artery. The interior of the left atrium presents for examination: (1) the orifices of the four pulmonary veins, (2) the left

atrioventricular orifice, (3) the orifices of the venæ cordis minimæ, and (4) musculi pectinati.

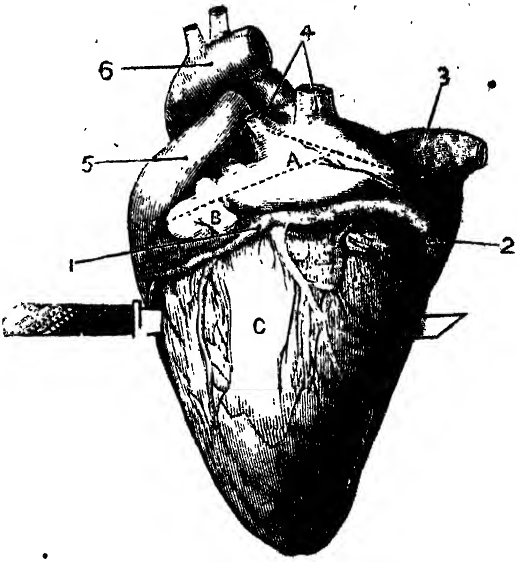


Fig. 39. Diagram showing how the left atrium and left ventricle should be opened. The dotted lines indicate the directions for opening the left auricle. The wall of the left ventricle is seen to be transfixed by a knife.

A. Left atrium.
B. Left auricula.
C. Left ventricle.
1. Great cardiac vein.
2. Coronary sinus.
3. Right pulmonary vein.
4. Two left pulmonary veins.
5. Pulmonary artery.
6. Aortic arch.

The *orifices of the four pulmonary veins* are seen on the posterior wall of the atrium. Oxygenated blood from the lungs is brought into the left atrium by the pulmonary veins. The left two pulmonary veins often open by a common orifice. These orifices are not guarded by

valves. The *left atrioventricular orifice* is smaller than that on the right side. It admits the tips of two fingers. It is guarded by the bicuspid or mitral valve. The *orifices of the venæ cordis minimæ* are fewer than those in the right atrium.

The *musculi pectinati* are smaller and fewer than those in the right atrium and are limited to the auricula only.

On the interatrial septum a small depression is sometimes seen bounded below by a semilunar ridge. This depression corresponds to the fossa ovalis seen on the other side of the septum.

To examine the interior of the left ventricle, a triangular flap is to be raised from its wall with the apex below (Fig. 39). The ventricle is to be transfixed a little to the left of the anterior longitudinal sulcus below the coronary

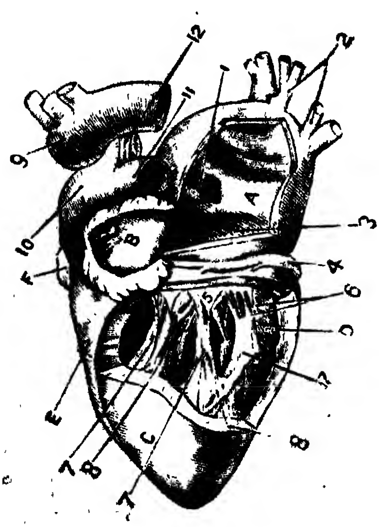


Fig. 40.—The interior of the left atrium and left ventricle. (From Wilson).

A. Cavity of the left atrium.
B. Cavity of the auricula in which are seen the musculi pectinati.
C. Left ventricle.
D. Cavity of the left ventricle.
E. Right ventricle.
F. Apex of the right auricula.
1. Opening of the two right pulmonary veins.
2. Left pulmonary veins.
3. Auriculo-ventricular opening.
4. Coronary sinus.
5. Mitral valve.
6. Chordæ tendineæ.
7. Musculi papillares.
8. Trabeculæ carneæ.
9. Aortic arch.
10. Pulmonary artery.
11. Left pulmonary artery.
12. Ligamentum arteriosum.

sulcus and the knife pushed till its point pierces the posterior wall a little to the left of the posterior longitudinal

sulcus. The knife is then to be carried downwards towards the apex.

The **Left Ventricle** is conical in shape and its walls are three times as thick as those of the right ventricle. The following parts require to be examined in its interior :—(1) The left atrioventricular opening and (2) mitral valve ; (3) the aortic opening and (4) aortic semilunar valves ; (5) the trabeculæ carneæ and (6) chordæ tendineæ.

The *left atrioventricular orifice* is situated below and to the left of the aortic orifice.

The *mitral* or *bicuspid valve* is similar in structure to the tricuspid valve but consists of two cusps which are larger and thicker than those of the tricuspid valve. The *anterior* or *aortic cusp* is larger than the posterior and lies in front and to the right of the atrioventricular orifice. The *posterior cusp* lies behind and to the left of the atrioventricular opening. The free margins of the cusps and their ventricular surfaces give attachment of the chordæ tendineæ.

The *aortic orifice* is situated in front and to the right of the left atrioventricular orifice. It is guarded by the aortic semilunar valves. The portion of the ventricular cavity just below the aortic orifice is called the aortic vestibule and is destitute of muscular tissue.

The *aortic semilunar valves* are three in number of which two are posterior (right and left) and one anterior. They are larger and thicker than the pulmonary semilunar valves. The nodules at the free margins of the valves are more prominent and the lunulæ are more distinctly seen. The pouches between the cusps and the wall of the aorta, called the *aortic sinuses* (sinuses of Valsalva), are larger than those of the pulmonary artery ; moreover the orifices of the coronary arteries are seen in these sinuses. The right coronary artery arises from the anterior aortic sinus while the left from the left posterior sinus.

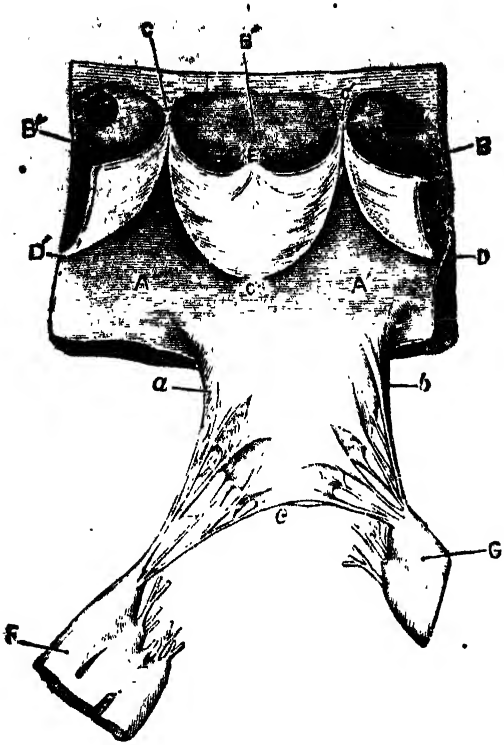


Fig. 41.—Diagram to illustrate the attachments of one flap of the mitral and the aortic valves (after Heath).

A, A'. Portion of the ventricular wall and
B, B', B''. aorta.
B, B', B''. Sinuses of aorta in B and B'', openings of coronary arteries are seen.
C, C' } Attached border of
D, D' } semilunar valve.
E. Nodule of the valve seen in the middle of the free border of the valve. The lunulæ are seen on either side of E.
F, G. Musculi papillares.
a, b, c. Attachment of the chordæ tendineæ.

The *trabeculæ carneæ* are of three kinds, as in the right ventricle, but they are more numerous and form a very dense network upon the posterior wall of the ventricle

and at the apex. The *musculi papillares* are thicker and stronger than those in the right ventricle. They are two in number; one attached to the anterior wall and the other to the posterior wall of the ventricle. They give attachment to the chordæ tendineæ by their free rounded extremities. The chordæ tendineæ from each papillary muscle are attached to the margins and ventricular surfaces of both cusps of the mitral valve.

The *interventricular septum* is thick and muscular at its lower part, but thin and membranous at its upper part. The thin upper portion consists only of fibrous tissue covered by endocardium and is called the *pars membranacea septi*. It constitutes a part of the wall of the aortic vestibule. The lower portion of the septum is specially thick near the apex of the heart. The anterior margin of the septum is attached opposite the anterior longitudinal sulcus and the posterior margin opposite the posterior longitudinal sulcus. The septum bulges into the right ventricle, hence the cavity of the right ventricle is semilunar on section and that of the left ventricle is circular.

The great vessels of the heart are now to be studied.

The **Superior Vena Cava** is a short trunk about three inches in length. It is formed behind the lower border of the right first costal cartilage close to the sternum by the junction of the two innominate veins. It descends vertically, pierces the pericardium and opens into the upper and back part of the right atrium. In the *upper half* of its course it lies in the superior mediastinal space, the right mediastinal pleura and the right phrenic nerve being placed on its right side; while on its left side, is the innominate artery. In the *lower half* of its course, it is enclosed within the fibrous layer of the pericardium and lies in the middle mediastinal space; the serous layer of the pericardium covers this portion in front and at

the sides; the ascending aorta is placed on its left side, while the right pulmonary artery and the upper right pulmonary vein lie behind it.

Tributaries.—The superior vena cava receives a large vein viz., the azygos vein immediately before its pierces the pericardium. Besides this large tributary several small mediastinal and pericardiac veins pour their contents into it.

The Inferior Vena Cava has a very short course in the thoracic cavity. If the heart is lifted up, the vein will be seen to enter the pericardium after piercing the central tendon of the diaphragm. It opens into the lower and back part of the right atrium.

The **Pulmonary Artery** is a short vessel, about two inches in length. It arises from the summit of the conus arteriosus and passes upwards and backwards at first in front of and then to the left side of the ascending aorta. It then divides opposite the fibrocartilage between the fifth and sixth thoracic vertebræ into a right and a left pulmonary artery. The serous layer of the pericardium encloses this vessel and the ascending aorta in a common tubular sheath. The right auricula and the right coronary artery lie to the right side of the vessel, while the left auricula and the left coronary artery lie to its left side.

The *right pulmonary artery* is longer and larger than the left. It passes lateralwards to the right behind the ascending aorta and the superior vena cava to the hilum of the right lung forming one of the constituents of its root. It divides into an upper and a lower branch. The former is distributed to the upper lobe, and the latter to the middle and lower lobes.

The *left pulmonary artery* passes lateralwards to the left in front of the descending aorta and the left bronchus to the hilum of the left lung, forming one of the constituents of its root. It divides into two branches, an upper

and a lower which are distributed to the upper and lower lobes of the left lung. The root of the left pulmonary artery is connected to the undersurface of the left part of the aortic arch by a short fibrous cord called the *ligamentum arteriosum.* It is the remains of a vessel, called the ductus arteriosus, which during fœtal life conveys the blood from the pulmonary artery to the aorta.

Pulmonary Veins. The tributaries of these vessels arise from the capillaries in the walls of the alveoli of the lungs. The smaller veins unite to from larger vessels which again unite to from a single vein for each lobe of the lung. The vein from the middle lobe of the right lung joins with that from the upper lobe before passing into the pulmonary root. In this way four terminal pulmonary veins are formed. two for each lung. The right *pulmonary veins* pass behind the superior vena cava and the right atrium, and open separately into the upper and back part of the left atrium. The *left pulmonary veins* pass in front of the descending aorta and open into the left atrium usually by separate orifices or sometimes by one common orifice. The relation of the pulmonary veins to the other constituents of the pulmonary root has been described.

Thymus. Mention has been made of the remains of the thymus gland. This organ attains its maximum size at the end of the second year. It then begins to dwindle and in the adult is usually represented by some connective tissue covering the great vessels of the superior mediastinum. The fully developed gland consists of two lateral lobes and extends above for a varying distance in the neck up to the lower end of the thyroid gland and below as far as the level of the fourth costal cartilage.

The **Aorta** is the great arterial trunk from which all the arteries of the body derive oxygenated blood. It begins at the aortic orifice of the left ventricle and ascends

obliquely to the right as far as the posterior surface of the right costal cartilage near the sternum. This portion is called the *ascending aorta*. Then it arches backwards and to the left and reaches the lower border of the body of the fourth thoracic vertebra on its left side forming the *arch of the aorta*. Finally it descends within the thorax on the left side of the bodies of the thoracic vertebræ and enters the aortic opening in the diaphragm. This portion is called the thoracic portion of the *descending aorta*.

The **Ascending Aorta** is enclosed by the serous layer of the pericardium in a tubular sheath common to it and the pulmonary artery. It presents three small dilatations at its commencement called the *aortic sinuses*. There is a fourth dilatation where it terminates in the arch of the aorta and is called the *bulb of the aorta* or the *great sinus of the aorta*. Its commencement is *covered* by the pulmonary artery and higher up it is overlapped by the anterior margin of the right lung and right pleura. The right atrium and the superior vena cava lie on its *right side*. The pulmonary artery lies on its *left side* at a higher level. *Posteriorly* it is in relation with the left atrium and the right pulmonary artery.

Branches.– These are the right and left coronary arteries and have been already studied.

The **Arch of the Aorta** lies in the superior mediastinum behind the manubrium sterni. *In front* it is covered by the pleuræ and lungs. It is crossed vertically along its left part by the left vagus and left phrenic nerves, the inferior cervical cardiac branch of the left vagus and the superior cervical cardiac branch of the left sympathetic nerve and the left superior intercostal vein. *Behind* it rests upon the trachea, the œsophagus, the thoracic duct, the left recurrent nerve and the deep cardiac plexus. *Above* it is in relation with the innominate vein and gives

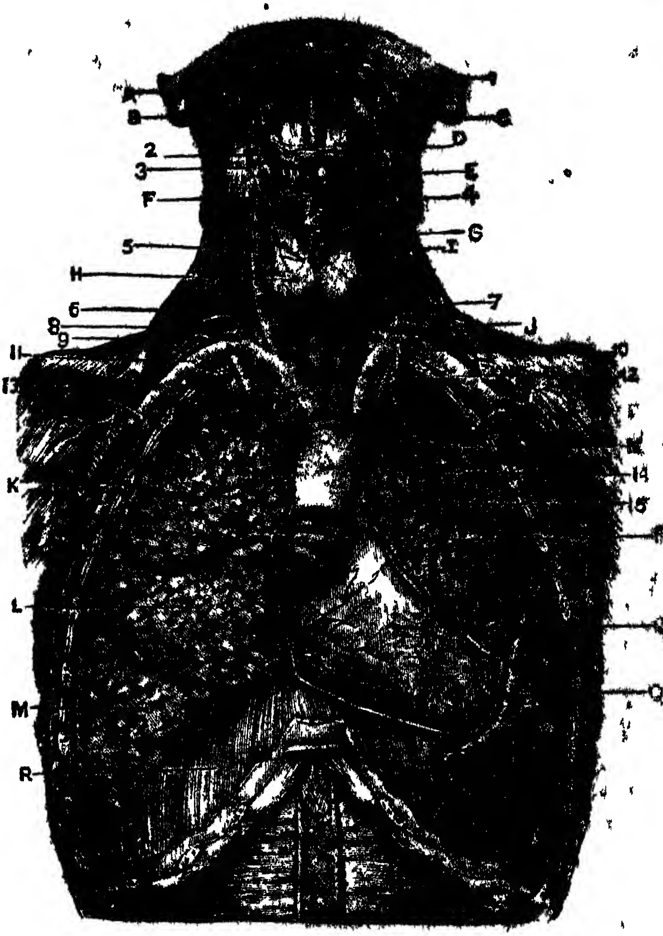


Fig. 42.—The heart and large vessels (after Bonamy and Beau).

A. Digastric.
B. Submaxillary gland.
C. Mylo-hyoid.

1. Submental branch of external maxillary artery.
2. External carotid artery.

D. Hyoid bone.
E. Thyreo-hyoid.
F. Thyreoid cartilage.
G. Crico thyreoid muscle.
H. Thyreoid gland.
I. Cricoid cartilage.
J. Trachea.
K. Right lung (upper lobe).
L. Right lung (middle lobe).
M. Right lung (lower lobe).
N. Left lung (upper lobe).
O. Left lung (lower lobe).
P. Right atrium.
Q. Right ventricle.
R. Diaphragm.

3. Internal carotid artery.
4. Superior thyreoid artery.
5. Right common carotid artery.
6. Inferior thyreoid artery.
7. Left common carotid artery.
8. Thyreo-cervical trunk.
9. Vertebral artery.
10. Left subclavian artery.
11. Right subclavian artery.
12. Internal mammary artery.
13. Innominate artery.
14. Arch of aorta.
15. Pulmonary artery.

origin to the innominate, left common carotid and left subclavian arteries. *Below*, in the concavity of the arch are the superficial cardiac plexus, the left recurrent nerve, the bifurcation of the pulmonary artery, the left bronchus and the ligamentum arteriosum.

Branches. These are (1) the innominate, (2) the left common carotid, and (3) the left subclavian.

The student will do well if he studies now the dissected heart of the fœtus noting the foramen ovale and the patent ductus arteriosus connecting the left pulmonary artery to the left side of the aortic arch.

The innominate veins and the branches of the arch of the aorta should now be studied.

The **Innominate Veins** are two in number, a right and a left. They are formed behind the sternal ends of the clavicles by the junction of the internal jugular and subclavian veins.

The **Right Innominate Vein** is about an inch in length. It passes downwards and slightly medialwards and unites with the left innominate vein to form the superior vena cava. On its *right side* is the right phrenic nerve. On its *left side* is the innominate artery. *In front* it is covered by pleura and *behind* it is the right vagus nerve.

The **Left Innominate Vein** is about three inches in

length. It passes obliquely downwards and to the right to unite with the right innominate vein. *In front of it* are the sterno-hyoid and sterno-thyeoid muscles and the remains of the thymus gland. *Behind* it are the innominate, left common carotid and left subclavian arteries, the left vagus and phrenic nerves.

Tributaries of the right and left innominate veins.—

The right innominate vein receives :—	The left innominate vein recieves :—
1. The right vertebral vein.	1. The left vertebral vein.
2. The right internal mammary vein.	2. The left internal mammary vein.
3. The right inferior thyreoid vein.	3. The left inferior thyreoid vein.
4. The right first intercostal vein.	4. The left first intercostal vein.
	5. The left superior intercostal vein.
	6,7. Some pericardiac and thymic veins.

The **Innominate Artery** is the largest branch of the arch of the aorta. It ascends obliquely to the right and divides behind the upper border of the right sterno-clavicular articulation into the right common carotid and the right subclavian arteries. *In front* it has the manubrium sterni, the origins of the sterno-hyoid and sterno-thyreoid muscles, the left innominate vein and the remains of the thymus gland. *Behind* it, is the trachea which is crossed by it obliquely. On its *right side* are the right innominate vein, the pleura and the right phrenic nerve ; on its *left side* are the left common carotid artery below and the trachea above.

Branches.—Usually no branch is given off from the innominate artery but occasionally a small artery, the

thyreoidea ima arises from it and passes in front of the trachea to supply the thyreoid gland.

The **Left Common Carotid Artery** arises from the arch of the aorta to the left of, and posterior to, the innominate artery. It consists of a thoracic portion and a cervical portion. The *thoracic portion* extends from the arch of the aorta to the left sterno-clavicular articulation. *In front* of it are the sternum, the origins of the left sterno-hyoid and sterno-thyreoid muscles, the left innominate vein and the remains of the thymus gland. *Behind*, it has at first the trachea, and higher up, the œsophagus, the left recurrent nerve and the thoracic duct. To its *right side* is the innominate artery below and the trachea higher up. To its *left side* are the left pleura and the left vagus nerve.

The **Left Subclavian Artery** issues from the aortic arch behind the left common carotid. It consists of a thoracic and a cervical portion. The *thoracic portion* extends from the aortic arch to the back part of the sternal end of the clavicle. *In front* it has the left common carotid artery, the left innominate vein and the left vagus nerve. *Behind* it are the œsophagus and the thoracic duct. To its *right side* it has the trachea and the left recurrent nerve below and the œsophagus and the thoracic duct above. To its *left side* are the left pleura and left lung.

Divide the superior and inferior venæ cavæ close to the heart as also the pulmonary artery and the pulmonary veins. The ascending aorta is to be severed at its junction with the arch of the aorta. The heart can now be removed from the body and its structure should be studied as far as it is possible in the dissecting-room.

Structure of the Heart.—The external surface of the heart is covered by the visceral layer of the serous pericardium, called the *epicardium*. Its cavities are lined by a smooth membrane called the *endocardium* which is

continuous with the inner coat of the blood vessels entering and leaving the organ. Between these two membranes is the *myocardium* or the muscular wall of the heart. In addition to these structures there exists what is called the "fibrous skeleton of the heart" which consists of four fibrous rings surrounding the four orifices of the heart viz., the two atrio-ventricular, the aortic and the pulmonary. The *atrioventricular rings* are interposed between the muscle fibres of the atria and the ventricles and give attachment to the tricuspid and mitral valves. The *aortic* and *pulmonary rings* are interposed between the muscle fibres of the ventricles and the muscular coats of the arteries, and the semilunar valves are attached to them. To examine the muscular fibres of the heart, a goat's heart (fresh) which can be easily procured, should be boiled for about a quarter of an hour so as to dissolve the connective tissue. It will then be seen that the *fibres of the atria* are distinct from those of the ventricles. The former are arranged in two layers, a superficial and a deep. The superficial layer runs transversely encircling both the atria. The deep layer runs antero-posteriorly from the atrioventricular rings and is limited to each atrium. The *fibres of the ventricles* are also arranged in two layers, a superficial and a deep. The superficial fibres common to both cavities begin at the atrioventricular rings and pass obliquely downwards to the apex. Reaching the apex they are coiled into a whorl forming what is called the vortex of the heart and pass upwards into the interior of the ventricles to the bases of the papillary muscles. The deep fibres are arranged in S—shaped manner and connect the papillary muscles of one ventricle with that of the other.

Remove the median cusp of the tricuspid valve by detaching it from the fibrous ring which surrounds the right atrioventricular opening. Peel off the endocardium

from the upper part of the interventricular septum near its posterior margin. A bundle of pale muscle fibres will be seen passing from the interatrial septum near the opening of the coronary sinus to the interventricular septum. After crossing the membranous part of the latter septum the bundle divides into two branches, a right and a left, which pass to the corresponding ventricles on the right and left surfaces of the septum and ultimately end at the bases of the papillary muscles of both ventricles. This bundle is called the *atrioventricular bundle* and establishes direct muscular continuity between the atria and the ventricles for the propagation of the wave of contraction.

The ligamentum arteriosum is to be divided and the arch of aorta to be hooked forwards and to the left. The deep cardiac plexus is now exposed.

The **Deep Cardiac Plexus** is situated behind the arch of the aorta and in front of the trachea at its bifurcation. It consists of a right portion and a left portion which are united with each other by communicating twigs. The *right portion* of the plexus is formed by (1) the three cardiac branches derived from the three cervical ganglia of the right sympathetic trunk, (2) the cervical and thoracic cardiac branches of the right vagus nerve, and (3) the cardiac branches of the right recurrent nerve. It distributes branches to the right anterior pulmonary plexus, the right atrium, the right coronary plexus, and to the superficial cardiac plexus. The *left portion* of the plexus is formed by (1) the middle and lower cardiac branches of the sympathetic trunk of the left side of the neck, (2) the upper cervical cardiac branch of the left vagus nerve, and (3) the cardiac branches of the left recurrent nerve. It distributes branches to the left anterior pulmonary plexus, the left atrium and the left coronary plexus.

The thoracic portion of the trachea should now be examined.

The **Trachea** is a wide tube which serves as the common air passage to both lungs, and is from four to four and a half inches in length. Its wall is formed partly by cartilage and partly by membrane. The cartilaginous rings occupy the front and side walls of the tube and are incomplete behind where the tube is completed by fibro-muscular membrane. In the thorax it passes through the back part of the superior mediastinal space and extends from the upper margin of the manubrium sterni to the upper border of the fifth thoracic vertebra where it bifurcates into the right and left bronchi. The thoracic part of the trachea has *in front* the manubrium sterni, the origins of the sterno-hyoid and sterno-thyreoid muscles, the left innominate vein, the arch of the aorta, the commencement of the innominate and the left common carotid arteries and the deep cardiac plexus. *Behind* it, is the œsophagus. On the *right side* are the pleura, the right vagus nerve and the terminal part of the innominate artery : on the *left side* are the arch of the aorta, the left common carotid and left subclavian arteries, and the left recurrent nerve.

The **Right Bronchus** is wider but shorter than the left, and is about an inch in length. It passes almost vertically to the root of the right lung and about three-fourths of an inch from its origin gives off a branch to the upper lobe of the right lung, called the *eparterial branch*, in consequence of its being given off above the pulmonary artery. It then passes behind and below the artery and is termed the *hyparterial branch* which divides into two branches for the middle and lower lobes of the right lung. The azygos vein passes over the right bronchus to end in the superior vena cava.

The **Left Bronchus** is narrower and longer than the right and is about two inches in length. It passes obliquely downwards and lateralwards beneath the arch of the

aorta and crosses the œsophagus and the descending aorta to reach the root of the left lung, behind and below the left pulmonary artery. It divides into two branches for the two lobes of the left lung. As the pulmonary artery is placed above the bronchus in the left pulmonary root, the branches of the left bronchus are called *hyparterial branches.*

Around the bifurcation of the trachea and along the bronchial tubes are many lymph glands called the *tracheobronchial lymph glands.* These lymph glands often contain black pigment.

Remove the anterior wall of the trachea first above the point of its bifurcation and note that the projecting septum which lies between the orifices of the two bronchi is inclined more to the left. For this reason and for the more vertical course of the right bronchus a foreign body dropped into the trachea would pass readily into the right bronchus.

The **Posterior Mediastinum.**—The boundaries of the posterior mediastinum have been described, (p. 162). A little careful dissection is necessary to expose its contents. The right lung is to be drawn out of its cavity and hooked towards the left side of the thorax. The pleura of the right side is to be removed from the posterior wall of the thorax, and from the posterior surface of the root of the right lung. This will bring into view the œsophagus, the right vagus nerve, the azygos vein, the thoracic duct, and the right splanchnic nerves. When these structures have been examined, a similar dissection is to be made on the left side by drawing out and hooking the left lung towards the right side of the thorax and stripping the parietal pleura from the inner surface of the ribs, the intercostal muscles and the sides of the vertebræ. The lower portion of the œsophagus, the thoracic aorta, the hemiazygos and accessory hemiazygos veins, the left

vagus and the left splanchnic nerves will then be seen. The contents of the posterior mediastinum may be tabulated in the following order :—

Vessels	1. Descending thoracic aorta. 2. Azygos vein. 3. Hemiazygos vein. 4. Accessory hemiazygos vein. 5. Thoracic duct.
Nerves	1, 2. Right and left vagus nerves. 3, 4. Right and left splanchnic nerves.
Other structures	Œsophagus. Lymph glands.

Œsophagus or Gullet.—The thoracic portion of the œsophagus descends through the superior and posterior mediastinal spaces and pierces the diaphgram opposite the tenth thoracic vertebra. Its termination in the stomach has been noted. In its course through the thorax it presents two curves. In the superior mediastinum it lies to the left of the median line of the vertebral column. But at the level of the fifth thoracic vertebra, it comes to the median line. Lower down it again inclines to the left of the middle line before passing through the diaphragm. *In front* of it are the trachea, the left bronchus, the pericardium, and the diaphragm. *Behind* it are the left longus colli muscle, the vertebral column, the azygos, hemiazygos and accessory hemiazygos veins, the right aortic intercostal arteries, the thoracic duct, and the lower part of the thoracic aorta. On its *right side* are the azygos vein and mediastinal pleura. On its *left side* are the left subclavian artery, the upper part of the thoracic duct, and the mediastinal pleura above, and the descending thoracic aorta, and the mediastinal pleura again below.

Below the roots of the lungs the œsophagus is encircled by the œsophageal plexus formed by the breaking up of the two vagi nerves on it. But before the œsophagus

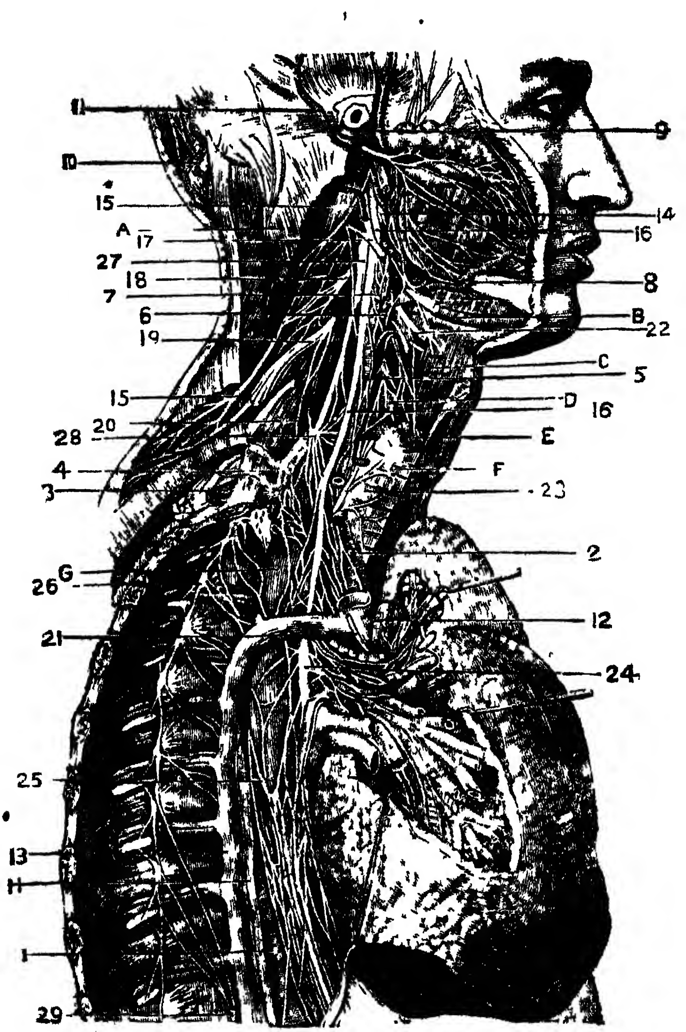


Fig. 48.—The course and distribution of the right vagus nerve (from Hirschfeld and Leveille).

A. Sterno-cleido-mastoideus (cut).
B. Digastricus.
C. Thyreo-hyoideus.
D. Inferior constrictor of pharynx.
E. Crico-thyreoideus.
F. Trachea.
G. Œsophagus.
H. Thoracic duct.

1. Thoracic aorta.
2. Innominate artery.
3. Subclavian artery.
4. Thyreocervical trunk.
5. Common carotid artery.
6. External carotid artery.
7. Internal carotid artery.
8. External maxillary artery.
9. Superficial temporal artery.
10. Occipital artery.
11. Posterior auricular artery.
12. Superior vena cava.
13. Vena azygos.
14. Glosso-pharyngeal nerve.
15. Accessory nerve.
16. Vagus nerve.
17. Hypoglossal nerve, its communication with second cervical nerve seen.
18. Third cervical nerve.
19. Fourth cervical nerve.
20. Phrenic nerve lying on scalenus anterior muscle.
21. Phrenic nerve (cut).
22. Superior laryngeal nerve.
23. Recurrent nerve.
24. Posterior pulmonary plexus.
25. Œsophageal plexus.
26. Sympathetic nerve.
27. Superior cervical ganglion of the sympathetic.
28. Middle cervical ganglion.
29. Greater splanchnic nerve.

passes through the diaphragm the left and right vagi nerves issue out of the plexus; the former occupies the anterior and the latter the posterior aspect of the gullet.

Vagus Nerve (Pneumogastric nerve).—The vagi nerves differ in their course in the thorax on the two sides, but both of them pass through the superior and posterior mediastinal spaces. The *right vagus* on entering the thorax passes behind the right innominate vein and along the right side of the trachea, giving off near its bifurcation the anterior plumonary branches. It then passes to the back of the root of the right lung, where it breaks up into several branches, which unite with filaments from the sympathetic trunk forming the posterior pulmonary plexus. From the lower part of this plexus two trunks issue and descend upon the œsophagus upon which they give off several branches which unite with the corresponding branches of the left side to form the œsophageal plexus (plexus gulæ). From this plexus the right vagus nerve issues as a single trunk which gains the posterior surface

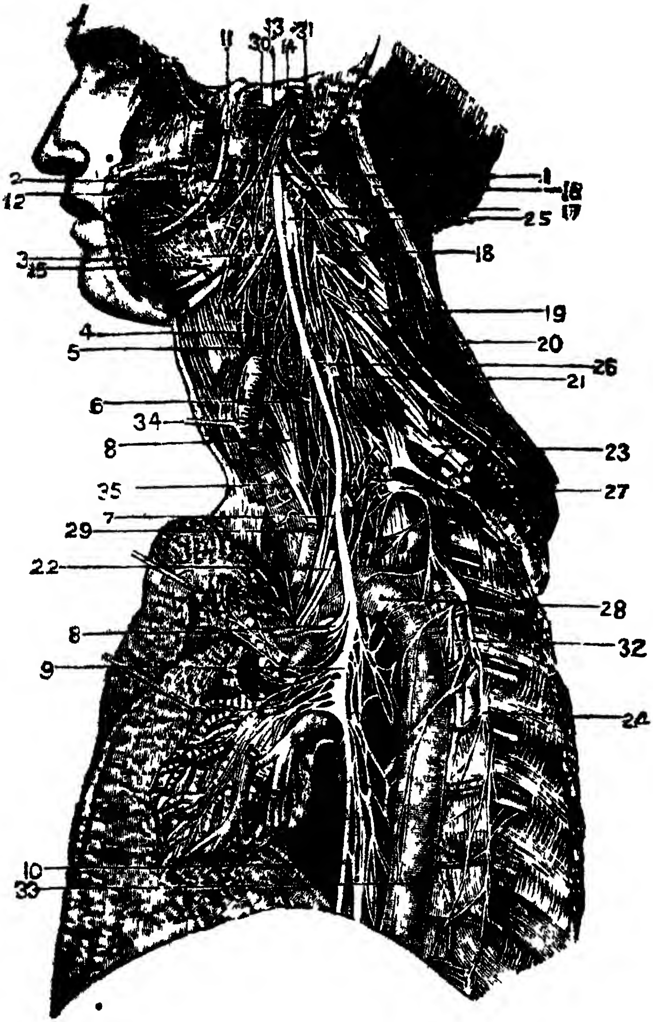


FIG. 44.—The course and distribution of the left vagus nerve (from Hirschfeld and Leveille).

1. Ganglion nodosum of the vagus nerve.
2. Pharyngeal branch of vagus.
3. Superior laryngeal nerve.
4. External laryngeal nerve.
5. Pharyngeal plexus lying on inferior constrictor muscle.
6. Superior cardiac nerve of vagus (upper).
7. Superior cardiac nerve of vagus (middle).
8. Left recurrent nerve.
9. Posterior pulmonary plexus of vagus.
10. Œsophageal plexus.
11. Semilunar ganglion of trigeminal nerve.
12. Lingual branch of mandibular nerve.
13. Glosso-pharyngeal nerve.
14. Accessory nerve.
15. Hypoglossal nerve.
17. Second cervical nerve communicating with first.
18. Third cervical nerve.
19. Fourth cervical nerve.
20. Accessory nerve communicating with cervical nerves.
21. Phrenic nerve (cut).
22. The same.
23. Brachial plexus.
24. Sympathetic nerve.
25. Superior cervical ganglion of sympathetic.
26. Middle cervical ganglion of sympathetic.
27. Inferior cervical ganglion of sympathetic.
28. Thoracic aorta.
29. Left common carotid artery.
30. Internal carotid artery.
31. Internal jugular vein (cut).
32. Accessory hemiazygos vein.
33. Hemiazygos vein.
34. Thyreoid gland.
35. Trachea.

of the œsophagus before it enters the œsophageal opening of the diaphragm.

The *left vagus* on entering the thorax lies between the left common carotid and the left subclavian arteries. Then it crosses the arch of the aorta and gives off its recurrent branch below the arch. Then it passes to the back part of the root of the left lung, where it breaks up into several branches which unite with filaments from the sympathetic trunk forming the posterior pulmonary plexus. From the lower part of this plexus two trunks issue and descend upon the œsophagus and give off several branches which unite with the corresponding branches of the right side forming the œsophageal plexus. From this plexus the left vagus emerges as a single trunk which gains the anterior aspect of the œsophagus before it leaves the thorax.

Branches.—Each vagus nerve gives off the following branches in the thorax:—(1) The *anterior pulmonary*

branches which are two or three filaments. They pass to the anterior aspect of the root of the lung, unite with filaments from the sympathetic trunk and form the *anterior pulmonary plexus.* (2) The *posterior pulmonary branches* are several large filaments which join with branches from the sympathetic trunk forming the *posterior pulmonary plexus.* Filaments are given off from this plexus to supply the bronchi and lungs. (3) The *œsophageal branches* join with branches from the opposite nerve and form the *œsophageal plexus* and supply the œsophagus and the back part of the pericardium. The right vagus nerve gives off one or two *cardiac branches* which join the deep cardiac plexus. The left vagus nerve gives off the *recurrent nerve* (recurrent laryngeal nerve) which arises after the trunk has crossed the arch of the aorta. The *left recurrent nerve* winds round the lower border of the aortic arch lateral to the ligamentum arteriosum and ascends along the left side of the trachea between it and the œsophagus. It gives off some cardiac branches which join the left part of the deep cardiac plexus.

The **Azygos Vein** (Vena azygos major) enters the thorax through the aortic opening of the diaphragm. Then it ascends along the right side of the vertebral column to the posterior aspect of the root of the right lung, and gaining its upper border arches forwards to open into the superior vena cava before it pierces the pericardium. In its course it lies upon the right intercostal arteries and is placed on the right side of the thoracic duct and descending thoracic aorta.

Tributaries.—The azygos vein receives (1) the right subcostal vein, (2) the lower eight intercostal veins of the right side, (3) the right superior intercostal vein, (4) the hemiazygos vein, (5) the accessory hemiazygos vein, (6) the right bronchial veins, (7) the œsophageal veins and (8) the pericardiac veins.

Thoracic Duct.—While dissecting the posterior abdominal wall the student has noticed that the thoracic duct begins in the abdomen in a dilatation called the cisterna chyli in front of the first and second lumbar vertebræ. On entering the thorax through the aortic opening of the diaphragm it lies to the right side of the aorta between it and the azygos vein. It ascends behind the œsophagus and in front of the vertebral column in the middle line crossing the right aortic intercostal arteries. At the level of the fourth or fifth thoracic vertebra it passes to the left of the middle line behind the arch of the aorta. It then ascends to the root of the neck behind the left subclavian artery and on the left side of the œsophagus. If the dissection of the neck has been sufficiently advanced the student will see that the thoracic duct reaching the seventh cervical vertebra arches lateralwards behind the internal jugular vein to terminate at the angle of junction of this vein with the left subclavian vein. It is provided with valves which are placed at short intervals.

Tributaries.—In the thorax the thoracic duct receives lymphatics from the left half of the thoracic cavity including the wall and viscera.

The *right broncho-mediastinal lymph trunk* is a small lymphatic vessel which ascends from the fifth thoracic vertebra to the root of the neck on the right side. It opens either into the right innominate vein or joins the right subclavian and jugular lymph trunks to form the *right lymphatic duct* which opens at the junction of the right internal jugular and subclavian veins like the thoracic duct on the left side. The right bronchomediastinal lymph trunk receives lymphatics from the upper part of the right lobe of the liver and the right half of the thoracic cavity including the right side of the heart.

Descending Aorta.—The thoracic portion of the descending aorta is the continuation downwards of the

arch of the aorta. It begins at the lower border of the fourth thoracic vertebra on its left side and descending through the posterior mediastinum ends in the aortic

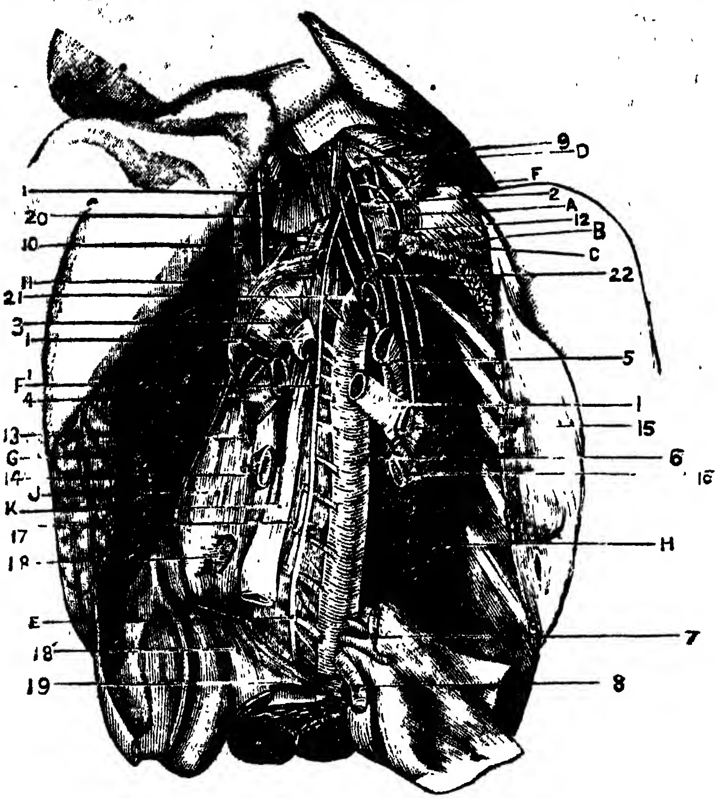


Fig. 45.—The posterior mediastinum seen from the front (from H. E. Browne).

A. Clavicle.
B. Left first rib.
C. Pectoralis major.
D. Left omo-hyoid.
E. Cisterna chyli.
F. Thoracic duct.
F'. The same.
G. Right lung.
H. Left lung.
I. Commencement of left bronchus.
I'. Left bronchus.
J. Pericardium.
K. Œsophagus.

1. Right common carotid artery.
2. Left thyreo-cervical trunk.
3. Arch of aorta.
4. Right pulmonary artery.
5. Left pulmonary artery.
6. Thoracic aorta.
7. Cœliac artery.
8. Superior mesenteric artery.
9. Left internal jugular vein.
10. Right innominate vein.
11. Superior vena cava.
12. Junction of left internal jugular and subclavian veins.
13. Right pulmonary vein.
14. The same.
15. Left pulmonary vein.
16. The same.
17. Vena azygos.
18. Inferior vena cava.
19. Left renal vein.
20. Right vagus nerve.
21. Left recurrent nerve.
22. Left phrenic nerve.

opening of the diaphragm opposite the lower border of the twelfth thoracic vertebra. Thence it is continued downwards as the abdominal aorta. At its commencement it lies to the left of the vertebral column but gradually approaches the median line. *In front* it has the root of the left lung, the pericardium, the œsophagus and the crura of the diaphragm, in that order from above downwards. *Behind* it are the vertebral column, the hemiazygos and accessory hemiazygos veins. *On its right side* are the œsophagus (above), the azygos vein and the thoracic duct. On the *left side* it has the mediastinal pleura, the left lung and the œsophagus (below).

Branches.—(1) *Intercostal* and (2) *subcostal arteries.* These will be examined later. (3) *Bronchial arteries.* These have been described (p. 168). (4) *Pericardiac branches.* These are a few small twigs distributed to the back part of the pericardium. (5) *Œsophageal branches.* These are four or five in number and ramify in the wall of the œsophagus and anastomose above with the œsophageal branches of the inferior thyreoid artery and below with the œsophageal branches of the left gastric artery. (6) *Posterior mediastinal branches.* These are minute twigs supplying the areolar tissue and lymph glands of the posterior mediastinum. (7) *Superior phrenic branches.* These are a few twigs which issue from the lower part of the thoracic aorta and supply the posterior part of the upper surface of the diaphragm.

Thoracic Lymph Glands.—Of these (1) the *sternal* or *internal mammary lymph glands* accompanying the internal mammary artery; (2) the *anterior mediastinal glands* in the lower portion of the anterior mediastinum, and (3) the *tracheobronchial glands* in and around the bifurcation of the trachea and the bronchi have been examined. (4) The *superior mediastinal glands* lie in the anterior part of the superior mediastinum in front of the arch of the aorta and in relation with its three branches. They receive lymphatic vessels from the pericardium, the heart and the thymus. (5) The *posterior mediastinal lymph glands* lie by the side of the descending thoracic aorta and receive lymphatic vessels from the pericardium, œsophagus, diaphragm and the upper surface of the liver. (6) The *intercostal lymph glands* are seen on the posterior thoracic wall in the posterior ends of the intercostal spaces and on the heads of the ribs. They receive lymphatic vessels from the posterior parts of the intercostal spaces.

Divide the trachea about an inch above its bifurcation and remove the lungs from the thoracic cavity. Trace the divisions of the bronchi and the pulmonary vessels in the substance of the lung. If one of the branches of the bronchus is traced inside the lung it will be seen to give off alternately ventral and dorsal branches. The former pass towards the anterior and the latter to the posterior border of the lung. These branches gradually diminish in their size and the cartilages which are regularly arranged in the walls of the bronchi become irregularly scattered in the walls of these branches and eventually disappear, leaving a musculomembranous wall.

The subdivisions of the pulmonary vessels, accompany the ramifications of the bronchial tubes in the substance of the lung.

Sympathetic Nerve.—The thoracic portion of the sympathetic nerve is usually composed of twelve ganglia linked

together by intervening cords. Each ganglion is placed against the head of a rib except the last two which lie on the side of the bodies of the eleventh and twelfth thoracic vertebræ. Sometimes there are ten or eleven ganglia owing to the fusion of two ganglia into one. Each ganglion is connected with the corresponding thoracic spinal nerve by two branches called the rami communicantes. Of the two branches one is grey and the other white. The white ramus communicans comes from the spinal nerve to the sympathetic ganglion and the grey ramus communicans goes from the ganglion to the spinal nerve.

Branches.—(1) The *aortic branches* are minute filaments passing from the upper five ganglia to the wall of the aorta. (2) The *pulmonary branches* pass from the second, third and fourth ganglia to the posterior pulmonary plexus. (3) The *greater splanchnic nerve* is formed by branches from the fifth or sixth to the ninth thoracic ganglia. These branches descend obliquely medialwards by the side of the bodies of the thoracic vertebræ and unite to from the trunk of the nerve which pierces the crus of the diaphragm and ends in the upper part of the cœliac ganglion. Often a ganglion called the *splanchnic ganglion* is developed on the nerve before it pierces the diaphragm. (4) The *lesser splanchnic nerve* is usually formed by two branches from the tenth and eleventh thoracic ganglia. It pierces the crus of the diaphragm and ends in the aorticorenal ganglion. (5) The *lowest splanchnic nerve* arises from the twelfth thoracic ganglion, perforates the crus of the diaphragm and terminates in the renal plexus.

The **Hemiazygos Vein** (Vena azygos minor inferior) begins in the abdomen as the left ascending lumbar vein. It enters the thorax through the left crus of the diaphragm and ascends to the level of the eighth thoracic vertebra along the left side of the vertebral column, crossing the left intercostal arteries in its course. Then it crosses the

vertebral column from the left to the right behind the descending aorta, the thoracic duct and the œsophagus and opens into the azygos vein. Its tributaries are the left subcostal vein, the lower three of four left intercostal veins and sometimes the accessory hemiazygos vein.

The **Accessory Hemiazygos Vein** (Vena azygos minor superior) is formed usually by the veins from the fourth to the eighth intercostal spaces of the left side. It descends along the left side of the vertebral column and at the level of the seventh thoracic vertebra crosses to the left to open into the azygos vein or sometimes into the hemiazygos vein.

THE POSTERIOR THORACIC WALL.

The dissector should now examine the posterior part of the thoracic wall from within.

The *posterior intercostal membrane* is the continuation medialwards of the internal intercostal muscle from the angle of the rib laterally to the anterior costo-transverse ligament medially. It covers the deep surface of the external intercostal muscle.

The *subcostales* are muscular slips placed on the inner surfaces of the ribs near their angles. The direction of their fibres is like that of the internal intercostal muscles. They arise from the inner surface of one rib and are inserted into the inner surface of the rib below or may skip over two or three intercostal spaces before insertion.

The student should note that the external intercostal muscles behind the posterior intercostal membrane extend medially up to the tubercles of the ribs.

Intercostal Arteries.—The intercostal arteries which supply the first two intercostal spaces are derived from the superior intercostal artery which is a branch of the costocervical trunk of the subclavian artery ; while in the nine lower intercostal spaces, they (the nine pairs of aortic

intercostal arteries) are derived from the thoracic aorta. In consequence of the thoracic aorta lying to the left of the median line of the vertebral column the right aortic intercostal arteries are longer than the left. The *right aortic intercostals* cross the bodies of the thoracic vertebræ behind the œsophagus, the thoracic duct and the azygos vein and lie under cover of the parietal pleura. The *left aortic intercostal arteries* pass backwards on the sides of the thoracic vertebræ and lie under cover of the pleura. From the sides of the bodies of the thoracic vertebræ the further course of the intercostal arteries on both sides is almost the same. They pass lateralwards behind the parietal pleura and the sympathetic nerve trunk and enter the intercostal spaces. Here each artery at first lies on the posterior intercostal membrane covered by the parietal pleura and then between the internal and external intercostal muscles in the costal groove. In the costal groove the companion vein lies above and the intercostal nerve lies below. Its further course has been described (p. 152). Each intercostal artery gives off a *dorsal branch* as it enters the intercostal space which passes backwards medial to the anterior costo-transverse ligament and opposite the intervertebral foramen gives off a *spinal branch* which enters the vertebral canal to supply the medulla spinalis and its membranes. Then the dorsal branch divides into a medial and lateral branch which will be studied during the dissection of the back.

The **Subcostal Arteries** are two in number, one on each side. They are in a line with the intercostal arteries and arise from the back part of the thoracic aorta. They pass lateralwards below the twelfth rib accompanied by the twelfth thoracic nerve and enter the abdominal wall beneath the lateral lumbocostal arch. Their further course has been described (p. 33).

The **Superior Intercostal Artery** is a branch of the

costo-cervical trunk. It descends in front of the neck of the first rib and opposite the first intercostal space divides into the first and second intercostal arteries. The *first intercostal artery* runs along the first intercostal space and the *second intercostal artery* descends in front of the neck of the second rib to the second intercostal space along which it runs. Their course and distribution are like those of the upper aortic intercostal arteries.

Thoracic Nerves.—The posterior portions of the thoracic nerves are now seen. They are the anterior divisions of the thoracic nerves and are twelve in number on each side. They differ from the other spinal nerves in not joining with one another to form a plexus. Their connection with the ganglia of the sympathetic trunk by the white and grey rami communicantes has been described (p. 104). The greater portion of the *first thoracic nerve* ascends in front of the neck of the first rib to join the brachial plexus. The smaller portion of it is continued in the intercostal space like the other intercostal nerves but it gives off no lateral cutaneous branch. The *second thoracic nerve* sometimes sends a communicating filament upwards along the neck of the second rib to join the portion of the first nerve which goes to the brachial plexus. The *third* to the *eleventh* (inclusive) *thoracic nerves* lie at first on the posterior intercostal membrane covered by parietal pleura. Near the angles of the ribs they pass between the internal and external intercostal muscles. Their further course and distribution have been noted (p. 151). The *twelfth thoracic nerve* accompanies the subcostal artery and its course and distribution have been examined (p. 107).

The Intercostal Veins are eleven in number on each side. There is a single vein in each space which is placed above the corresponding artery in the costal groove. On the *right side* the first intercostal vein, called the highest

intercostal vein, terminates usually in the right innominate vein. The second and third intercostal veins unite to form the superior intercostal vein which opens into the azygos vein. The remaining right intercostal veins open separately into the azygos vein. On the *left side* the highest intercostal vein opens usually into the left innominate vein. The superior intercostal vein formed by the union of the second and third intercostal veins opens into the left innominate vein. The fourth, fifth, sixth, seventh and eighth intercostal veins unite to form the accessory hemiazygos vein. The ninth, tenth and eleventh intercostal veins open into the hemiazygos vein.

The subcostal vein of the right side opens into the azygos vein and that of the left side into the hemiazygos vein.

ARTICULATIONS OF THE THORAX.

I. **Sterno-costal Joints.**—The cartilages of the upper seven ribs articulate with the sternum. The joint between the first costal cartilage and the manubrium sterni is a synchondrosis and there is no synovial cavity between the cartilage and the sternum. The remaining six sterno-costal joints are arthrodial joints. The ligaments connecting the articular surfaces are :—(1) The *radiate sternocostal ligaments* which are strong bands that radiate from the anterior and posterior surfaces of the sternal ends of the costal cartilages. On the sternum they blend with the periosteum. (2) The *interarticular sternocostal ligaments* which pass from the extremity of the costal cartilages to the side of the sternum. These ligaments subdivide the joint cavities into an upper and a lower compartment lined by separate synovial strata. This ligament is always present in the joint between the second costal cartilage and the sternum and in the lower ones it is usually absent.

Where it is absent there may be one synovial cavity or none at all.

II. **Interchondral Joints.**—These are diarthrodial joints between the contiguous margins of the sixth, seventh, eighth, ninth and tenth costal cartilages. Each joint is enclosed by an articular capsule lined by a synovial stratum.

III. **Intersternal Joints.**—These are two in number, one between the manubrium sterni and the gladiolus and the other between the gladiolus and the xiphoid process. The former is a symphysis ; the lower margin of the manubrium and the upper margin of the gladiolus being coated with cartilage and joined to each other by a piece of fibrocartilage. The joint is strengthened in front and behind by longitudinal fibres. The joint between the gladiolus and the xiphoid process is a synchondrosis ; the cartilage intervening between the segments ossifies after middle age.

IV. **Costovertebral Joints.**—These include two sets of articulations : (*a*) Articulations of the heads of the ribs (capitular articulations) and (*b*) Articulations of the necks and tubercles of the ribs (costo-transverse articulations.)

(*a*) **Capitular Articulations** (arthrodia).—The head of a rib articulates with the cavity formed by the costal facets on the sides of two contiguous vertebræ and the intervertebral fibrocartilage between them. The first, tenth, eleventh and twelfth ribs articulate with single facets on the vertebræ of the same number. The following ligaments are seen in these joints :—(1) The *articular capsules* connect the head of the rib to the articular cavity formed by two contiguous vertebræ and the intervening fibro-cartilage. Two articular capsules are seen in the joints from the second to the ninth ribs because an interarticular ligament divides each of these joints into two. In the case of the first, tenth, eleventh and twelfth ribs

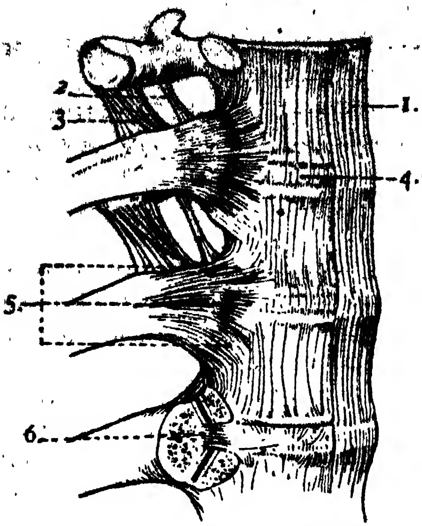


Fig. 46.—Ligaments of the costo-vertebral and costo-transverse joints.

1. Anterior longitudinal ligament.
2. Posterior costo-transverse ligament.
3. Anterior costo-transverse ligament.
4. Intervertebral fibro-cartilage.
5. Radiate ligament.
6. Interarticular ligament.

the capsule is not divided into two. (2) The *interarticular ligament* connects the interarticular ridge on the head of a rib with the intervertebral fibrocartilage. It subdivides the joint cavity into two, an upper and a lower, which are lined by separate synovial strata. This ligament is absent in the first, tenth, eleventh and twelfth ribs and hence there is only one synovial stratum lining the capsule. (3) The *radiate ligament* (stellate ligament) extends from the anterior surface of the head of each rib to the sides of the vertebræ above and below and to the intervening fibrocartilage in a radiating manner.

(*b*) **Costo-transverse Articulations.**—The articular portion of the tubercle of a rib articulates with the transverse process of the corresponding vertebra and forms an arthrodial joint. The following ligaments are seen in the joint:—(1) The *articular capsule* surrounds the articular facet on the tubercle of a rib and on the anterior surface of the tip of a transverse process. It is lined by a synovial stratum and is absent in the eleventh and

twelfth ribs. (2) The *ligament of the tubercle of the rib* is a thickening on the posterior part of the capsule extending from the tip of the transverse process to the rough portion of the tubercle of the rib. (3) The *anterior costotransverse ligament* extends from the upper border of the neck of the rib to the lower border of the transverse process of the vertebra above. (4) The *posterior costotransverse ligament* extends from the neck of the rib behind the attachment of the anterior costotransverse ligament to the base of the transverse process and the adjoining part of the inferior articular process of the vertebra above. (5) The *ligament of the neck of the rib* (middle costotransverse ligament) binds the posterior surface of the neck of a rib to the anterior surface of the transverse process against which it lies.

V. The **Intervertebral Joints** comprise (*a*) the articulations between the bodies of the vertebræ and (*b*) the articulations between the vertebral arches.

The articulations between the bodies of the vertebræ constitute amphiarthrodial joints. The ligaments connecting them are :—(1) The *anterior longitudinal ligament* (anterior common ligament) extends along the front of the bodies of the vertebræ. It is broader below than above and firmly attached to the anterior surfaces of the bodies of the vertebræ and to the intervertebral fibrocartilages. It is narrow opposite the central parts of the bodies. Its superficial fibres are long and deep fibres short. (2) The *posterior longitudinal ligament* (posterior common ligament) extends along the posterior surfaces of the bodies of the vertebræ. It is broad where it is attached to the intervertebral fibrocartilage and to the contiguous margins of the bodies of the vertebræ. It is narrow opposite the central parts of the bodies from which it is separated by the basivertebral veins. (3) The *intervertebral fibrocartilages* are discs of white fibrocartilage placed between

the contiguous surfaces of the bodies of the vertebræ. In the thoracic region they are almost of uniform thickness. Their peripheral portions are fibrous and the central portions are soft and pulpy. Laterally they are attached to the interarticular ligaments of the costovertebral articulations. (4) The *intertransverse ligaments* extend between the tips of the transverse processes. (5) The *articular capsules* are attached to the margins of the articular processes of adjacent vertebræ. They are usually thin and loose. (6, 7, 8) The ligamenta flava, connecting the laminæ and the interspinal and supraspinal ligaments, connecting the spinous processes will be studied during the dissection of the back.

HEAD AND NECK.

When the subject is brought into the dissecting-room it is placed in the lithotomy position The dissector of the head and neck starts work at once. The work assigned to him on the first, second and third days is the dissection of the scalp and the temporal region.

THE SCALP AND THE TEMPORAL REGION.

Surface Anatomy.—Before beginning to reflect the skin the following landmarks should be felt and recognised on the cranium:—the glabella, the superciliary arch, the supraorbital margin, the zygomatic process of the frontal bone, the parietal tuberosity, the superior temporal line, the zygomatic arch, the mastoid process and the external occipital protuberance.

Incisions.—The head should be shaved and raised on a block. Give one incision from the root of the nose backwards along the middle line to the external occipital protuberance. Another incision is to be made from the tip of the mastoid process on one side to the same point

on the opposite side along the vertex of the skull and accross the line of the first incision. A third incision is to be given on each side by carrying the knife from the tip of the mastoid process in an arched manner over the pinna of the ear to the posterior root of the zygomatic process.* The two flaps of the skin in front are to be reflected to the level of the supraorbital margins in front and the zygomatic arches laterally. The remaining two flaps of the skin behind are to be reflected to the level of a line joining the external occipital protuberance to the tip of the mastoid process.

The term "scalp" includes the soft structures covering the skull between the supraorbital margins in front, the superior temporal lines at the sides and the superior nuchal lines behind. The "temporal region" includes the portion lying between the superior temporal line and the zygomatic arch.

There are *five layers* in the scalp in the following order from without inwards.

1. The skin.
2. The superficial fascia.
3. The epicranius with its aponeurosis.
4. The subaponeurotic areolar tissue.
5. The pericranium.

There are *eight layers* in the temporal region in the following order from without inwards.

1. The skin.
2. The superficial fascia.
3. The extrinsic muscles of the ear.
4. The thin lateral portion of the aponeurosis of the epicranius.
5. A thin layer of fascia which descends from the superior temporal line to the pinna.
6. The temporal fascia.
7. The temporal muscle.
8. The pericranium.

Besides these strata the following vessels and nerves are met with in the scalp:—

Vessels — 1. **Frontal.** 2. **Supraorbital.** 3. **Superficial temporal.** 4. **Posterior auricular.** 5. **Occipital.**

Nerves

1. **Supratrochlear.** 2. **Supraorbital.**	**In the frontal and parietal regions.**
3. Temporal branches of the facial nerve. 4. Zygomatico-temporal branch of the zygomatic nerve. 5. Auriculo-temporal nerve.	**In the temporal region.**
6. Posterior auricular branch of the facial nerve. 7. Posterior branch of the great auricular nerve. 8. Smaller occipital nerve. 9. Greater occipital nerve.	**In the mastoid and occipital regions.**

The **Skin** of the scalp is firmly attached to the epicranius by the fibrous processes of the superficial fascia; hence the difficulty in separating the skin from the superficial fascia and the mobility of the hairy scalp during the contraction of the epicranius.

The **Superficial Fascia** is a firm dense layer of fibrous tissue containing numerous lobules of fat. It is firmly attached to the overlying skin and to the epicranius lying underneath.

Remove the superficial fascia taking care that the cutaneous nerves and blood-vessels which ramify in it are not injured.

The **Epicranius** (Occipito-frontalis) is placed symmetrically one on each side of the cranial vault and consists of an anterior muscular portion called the frontalis, a posterior muscular portion called the occipitalis, and an intermediate aponeurotic portion called the galea aponeurotica.

The **Frontalis** is attached to the superficial fascia over the eyebrow and the root of the nose. Here its fibres are blended with those of the orbicularis oculi laterally and the corrugator and procerus medially. The fibres pass upwards and end in the aponeurosis near the coronal suture. Medially the muscle fibres of the two sides are continuous.

The **Occipitalis** arises (1) from the lateral two thirds of the superior nuchal line of the occipital bone and (2) from the adjacent mastoid portion of the temporal bone. The fibres pass upwards and end in the aponeurosis. Medially the muscles of the two sides are separated from each other by an interval occupied by a prolongation of the aponeurosis.

The **Galea Aponeurotica** (Epicranial aponeurosis) connects the frontalis with the occipitalis. Behind it is prolonged between the two occipitales muscles and is attached to the external occipital protuberance and the highest nuchal lines of the occipital bone. In front it is prolonged as a pointed process filling up the V-shaped gap between the upper parts of the frontales muscles. On either side a thin fascia is prolonged from its lateral margin to the zygomatic arch and gives origin to the anterior and superior auriculares.

Nerve-supply.—The frontalis is supplied by the temporal branches of the facial nerve and the occipitalis by the posterior auricular branch of the same nerve.

Make a short crucial incision into the galea aponeurotica over the vertex of the skull and raise the corners of

the flaps. This will reveal the layer of *subaponeurotic areolar tissue.* It connects loosely the aponeurosis to the pericranium.

The *pericranium* is the periosteum covering the cranium lying underneath the areolar tissue. Make an incision in the pericranium and reflect it from the surface of the bone for some distance. Observe that it is firmly attached to the sutures, but it can be easily separated from the intervening surfaces of the bones.

In the temporal region the extrinsic muscles of the ear lying beneath the superficial fascia are to be cleaned.

The **Extrinsic Muscles of the Ear** are three in number viz., the auricularis anterior, the auricularis superior and the auricularis posterior.

The *auricularis anterior* (attrahens aurem) lies in front of the auricula. Hook the ear backwards to make the fibres of the muscle prominent. The muscle is fan-shaped and arises by its base from the lateral margin of the galea aponeurotica and is inserted by its apex into the spina helicis.

The *auricularis superior* (attollens aurem) is also a fan-shaped muscle situated above the auricula. It may be made prominent by hooking the ear down. It arises by its broad base from the lateral margin of the galea aponeurotica and is inserted by its apex into the cranial surface of the pinna at its upper part.

The *auricularis posterior* (retrahens aurem) is situated behind the auricula and is made prominent by hooking the ear forwards. It arises from the mastoid portion of the temporal bone and is inserted into the cranial surface of the concha at its lower part.

Nerve-supply.—The auricularis anterior and superior are supplied by the temporal branches of the facial nerve. The auricularis posterior is supplied by the posterior auricular branch of the same nerve.

Vessels.—(1) The *frontal artery* is one of the terminal branches of the ophthalmic artery. It emerges from the orbit at its medial angle accompanied by the supratrochlear nerve. It supplies the skin and muscles over the

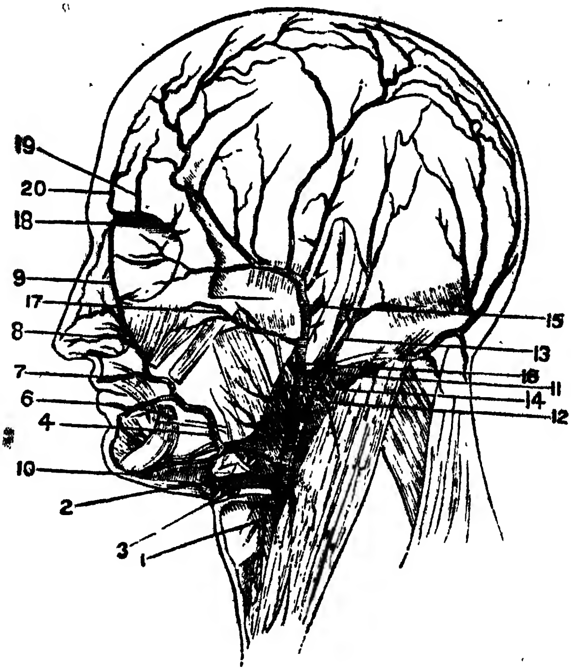


Fig. 47.—Arteries of the scalp and face (from Henle).

1. Superior thyreoid artery.
2. Lingual artery.
3. Hyoid branch of lingual artery.
4. External maxillary artery.
6. Inferior labial artery.
7. Superior labial artery and artery to septum.
8. Lateral nasal artery.
9. Angular artery.
10. Submental artery.
11. Occipital artery.
12. Sterno-cleido-mastoid branch of occipital artery.
13. Posterior auricular artery.
14. Ascending pharyngeal artery.
15. Superficial temporal artery.
16. Internal maxillary artery.
17. Transverse facial artery.
18. Branch of lacrimal artery.
19. Supraorbital artery.
20. Frontal artery.

front part of the forehead. (2) The *supraorbital artery* is derived from the ophthalmic artery. It emerges from the orbit through the supraorbital foramen accompanied by the supraorbital nerve. It supplies the skin and muscles of the forehead and anastomoses with the frontal artery and with the frontal branch of the superficial temporal artery. The *frontal* and *supraorbital veins* meet at the medial angle of the orbit to form the *angular vein.* (3) The *superficial temporal artery* is one of the terminal branches of the external carotid. It appears in the temporal region by crossing the posterior part of the zygomatic arch just in front of the ear in company with the auriculo-temporal nerve. It divides into an anterior or frontal and a posterior or parietal branch. The *frontal branch* passes upwards and forwards supplying the muscles and skin and anastomoses with the supraorbital and frontal arteries. The *parietal branch* curves upwards and backwards along the side of the head and anastomoses with the posterior auricular and occipital arteries and with its fellow of the opposite side. The *superficial temporal vein* begins on the side and vertex of the skull. Its termination cannot be seen now. (4) The *posterior auricular artery* is a branch of the external carotid. In the scalp it appears between the mastoid process and the ear and divides into an anterior or auricular branch and a posterior or occipital branch. The *auricular branch* passes upwards beneath the auricularis posterior, supplies the back part of the auricula and anastomoses with the parietal branch of the superficial temporal artery. The *occipital branch* runs backwards and anastomoses with the occipital artery. The *posterior auricular vein* begins on the side of the head and its termination cannot be seen now. (5) The *occipital artery* appears lateral to the external occipital protuberance in company with the greater occipital nerve. It passes upwards taking a

tortuous course and supplies the soft parts at the upper and back parts of the cranium. The *occipital vein* begins at the posterior part of the skull and its termination cannot be seen now.

Nerves.—(1) The *supratrochlear nerve* is the medial terminal branch of the frontal nerve. It emerges from the orbit at its medial angle and ascends beneath the corrugator and frontalis muscles. It then pierces the frontalis muscle and supplies the skin of the forehead near the middle line. (2) The *supraorbital nerve* is the lateral terminal branch of the frontal nerve. It emerges from the orbit through the supraorbital notch or foramen and ascends beneath the orbicularis oculi and frontalis muscles. It then divides into two branches, a medial and a lateral. The medial branch pierces the frontalis muscle and supplies the skin over the parietal bone. The lateral branch pierces the galea aponeurotica to supply the skin over the parietal bone. (3) The *temporal branches of the facial nerve* appear in the temporal region by crossing the zygomatic arch. They supply the corrugator supercilii, the orbicularis oculi, the frontalis and the auriculares anterior and superior muscles. (4) The *zygomatico-temporal branch of the zygomatic nerve* pierces the temporal fascia about an inch above the front part of the zygomatic arch. It supplies the skin of the temporal region. (5) The *auriculo-temporal nerve* is a branch of the mandibular nerve. Its terminal portion appears in the temporal region by crossing the zygomatic arch just in front of the ear in company with the superficial temporal artery. It divides into an anterior and a posterior branch which supply the skin of the scalp and the temporal region. (6) The *posterior auricular nerve* is a branch of the facial nerve. It ascends with the posterior auricular artery in the interval between the mastoid process and the ear and divides into an anterior or auricular branch and a pos-

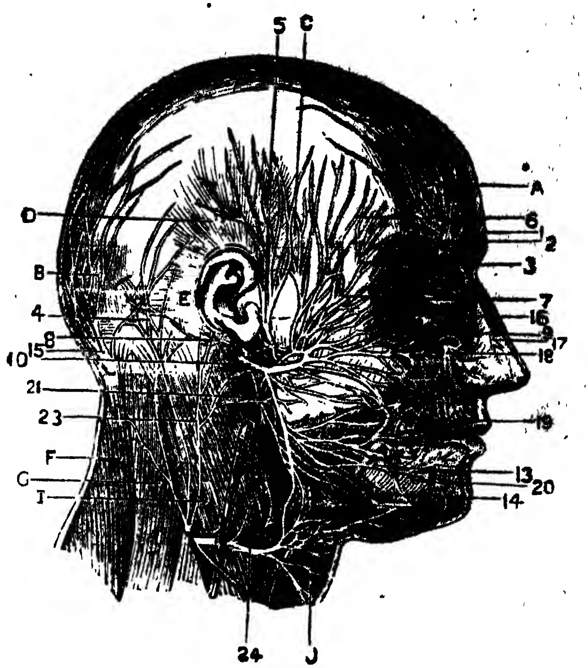


Fig. 48.—Nerves of the scalp, face and upper half of the side of the neck (from Hirschfeld and Leveille).

A. Frontalis muscle.
B. Occipitalis muscle.
C. Anterior auricular muscle.
D. Superior auricular muscle.
E. Posterior auricular muscle.
F. Trapezius.
G. Splenius capitis.
I. Sterno-cleido-mastoideus.
J. Platysma.
1. Supratrochlear nerve.
2. Supraorbital nerve.
3. Zygomatico-temporal nerve.
4. Small occipital nerve.
5. Auriculo-temporal nerve.
6. Temporal branch of facial nerve.
7. Zygomatic branches of facial nerve.
8. Posterior auricular nerve.
9. Infraorbital branches of facial nerve.
10. Facial nerve.
13. Buccal branches of facial nerve.
14. Mandibular branch of facial nerve.
15. Great occipital nerve.
16. Zygomatico-facial nerve.
17. External nasal nerve.
18. Infraorbital nerve.
19. Buccinator nerve.
20. Mental nerve.
21. Branches to digastric and stylo-hyoid muscles.
23. Great auricular nerve.
24. Transverse cutaneous colli nerve.

terior or occipital branch. The auricular branch supplies the auricularis posterior. The occipital branch passes backwards and supplies the occipitalis. (7) The *posterior branch of the greater auricular nerve* ascends close to the preceding nerve and supplies the skin over the mastoid process and on the back of the ear. (8) The *smaller occipital nerve* is derived from the anterior primary division of the second cervical or sometimes also from the third cervical nerve. It ascends behind the mastoid process and supplies the skin of the occipital and mastoid regions. It gives off an auricular branch which supplies the skin of the upper part of the cranial surface of the auricula. It communicates with the great auricular, the posterior auricular and greater occipital nerves. (9) The *greater occipital nerve* is the medial branch of the posterior division of the second cervical nerve. It lies close to the occipital artery and divides into many branches which supply the skin over the back part of the head as far forwards as the vertex. Sometimes it gives off an auricular branch which supplies the skin over the back part of the ear.

The remaining layers in the temporal region may now be examined. Reflect the lateral prolongation of the galea aponeurotica together with the superior and anterior auricular muscles towards the zygomatic arch. A *layer of thin fascia* is now seen beneath it passing from the superior temporal line to the pinna. This is the fifth layer in the temporal region. Reflect this fascia downwards from the superior temporal line. The *temporal fascia* attached to the superior temporal line is now exposed. This is the sixth layer in the temporal region. Detach the temporal fascia from the superior temporal line. The origin of the *temporalis muscle* is exposed. This is the seventh layer in the temporal region. Detach the temporal muscle from its origin from the temporal fossa and

reflect it downwards over the zygomatic arch. The *pericranium* which forms the eighth layer is now exposed.

REMOVAL OF THE BRAIN. THE DURA MATER, ITS PROCESSES AND SINUSES. THE EXIT OF THE CRANIAL NERVES. THE ARTERIES ENTERING INTO THE CRANIAL CAVITY. THE CRANIAL FOSSÆ.

The skull cap is now to be sawn through. The saw line which encircles the whole of the skull is marked with the knife by cutting the remaining layers of the scalp down to the bone. In front, this line is about three-fourths of an inch above the supraorbital margins. Behind, the line is about half an inch above the level of the external occipital protuberance. The ends of the lines in front and behind are to be joined together by carrying the edge of the knife along the lateral aspect of the skull. Divide the outer table of the skull by the saw. When the diploe is reached (which will be indicated by lessened resistance) the saw is no longer to be used. The inner table is then broken by the chisel and hammer. In this way any injury to the membranes or brain substance is avoided. When the skull cap has become loose, the hook at the end of the chisel is introduced into the cut in front and the cranial vault forcibly detached. The external surface of the dura mater is now brought into view.

The **Dura Mater** is the outermost covering of the brain which is enveloped by three membranes called the *meninges*. The innermost covering is called the *pia mater*; while between the dura mater and the pia mater is the intermediate covering called the *arachnoid*. The outer surface of the dura mater is rough and firmly adherent to the inner surfaces of the skull bones as has been noticed during the removal of the skull cap. Small

granular masses, called *arachnoideal granulations* are seen on either side of the middle line of the dura mater specially if the subject is old. Indentations on the inner surface of the skull cap on either side of the sagittal suture are seen corresponding to these outgrowths. These granulations are the outgrowths of the arachnoideal trabeculæ which have pushed and stretched the dura mater before them. If the outer surface of the dura mater is well sponged the ramifications of the middle meningeal artery on either side will be seen. On the inner surface of the skull cap that has been removed grooves corresponding to these branches of the artery are seen.

Pinch the dura mater with forceps and with a pair of scissors cut it antero-posteriorly on either side about half an inch lateral to the middle line. Make a vertical incision in each lateral flap from the centre of the first incision. Reflect the four flaps of dura mater thus formed over the sawn margin of the skull. The inner surface of the dura mater is now seen. It is smooth and free and is separated from the arachnoid by an interval called the *subdural space*. This space contains a little serous fluid enough to lubricate the opposed surfaces of the two membranes. The dura mater consists in reality of two layers an outer or *endosteal layer* which lines the inner surfaces of the cranial bones serving as an internal periosteum, and an inner or *meningeal layer* which forms and gives off processes between the different parts of the brain for their support. These two layers are intimately blended together except in some places where they separate and form venous channels called *sinuses*.

The superior sagittal sinus is now to be opened. It is contained in the central strip of dura mater which has been left in the middle line. Lay open the sinus by incising its exposed upper wall from behind forwards.

The **Superior Sagittal Sinus** (Superior longitudinal

sinus) is a venous channel situated between the two layers of the dura mater. It extends from the foramen cæcum in front to the internal occipital protuberance behind, grooving the inner surfaces of the cranial bones along the middle line of the skull. The lumen of the sinus is triangular, small in front and gradually increases in size as it is traced backwards. Slender fibrous bands traverse the sinus at its inferior angle. These bands are called *chordæ Willisii.* On either side are seen the projecting arachnoideal granulations and the mouths of recesses called lacunæ into which the cerebral veins open. The sinus terminates usually in the right lateral sinus. Emissary veins passing through the foramen cæcum and the parietal foramina join it and the superior cerebral veins open into it.

Pull the hemispheres of the cerebrum a little away from each other and note that the superior cerebral veins are passing medialwards along the surface of the hemispheres towards the lateral wall of the superior sagittal sinus. They do not however open into the sinus as soon as they reach its lateral wall but turn forwards lying against it and then open obliquely into the sinus. If a bristle is passed into one of these openings in the sinus it will point obliquely forwards and medialwards. This shows that the blood from these veins flows forwards into the sinus. The main current of blood in the sinus however flows from before backwards. Divide these cerebral veins and observe the process of the dura mater which sinks between the hemispheres antero-posteriorly. This is the falx cerebri.

The **Falx Cerebri** is a sickle-shaped process of the dura mater formed by the duplicature of its inner meningeal layer. In front it is attached to the crista galli of the ethmoid by its narrow extremity. Behind it is broad and is attached to the upper surface of the tentorium

cerebelli where it splits and forms with the tentorium a venous passage called the straight sinus. Its upper margin is convex and splits to enclose the superior sagittal sinus. Its lower margin is concave and free and contains the inferior sagittal sinus.

Removal of the Brain.—The student should now proceed to remove the brain. Divide the falx cerebri at its attachment to the crista galli and throw it backwards. Tilt the head a little backwards and support the hind part of the brain with the left hand,—this support should be continued till the whole brain is removed. The frontal lobes of the brain are then dislodged from the anterior fossa of the base of the skull as also the *olfactory bulbs* and *tracts* from the lamina cribrosa of the ethmoid with the handle of the scalpel. Next take a sharp scalpel and divide the cranial nerves in succession from before backwards as they perforate the dura mater. In dividing the nerves cut them short on one side and long on the other. Divide the *optic nerves* which will be seen close to the anterior clinoid processes as they enter the optic foramina. The *internal carotid arteries* which also come into view are also to be divided. The *pituitary body* is next to be dislodged from the fossa hypophyseos with the *infundibulum* attached to it by incising the margin of the diaphragma sellæ (a process of the dura mater encircling the infundibulum). The thick *oculomotor nerves* which lie lateral to the internal carotid arteries are then divided. The free margin of the tentorium cerebelli close to its attachment to the clinoid processes is now seen. Lying under cover of this free margin are the slender *trochlear nerves* which should be divided. At this stage the tentorium cerebelli which is situated between the posterior part of the cerebrum and the cerebellum should be divided carefully by carrying the knife superficially along its attached convex margin, so that

the cerebellum lying underneath may not be injured. The remaining cranial nerves are now to be divided. The two roots of the *trigeminal nerve* pierce the dura mater close to the apex of the petrous portion of the temporal bone. The *abducent nerve* pierces the dura mater below the posterior clinoid processes. The *facial* and *acoustic nerves* together with the *nervus intermedius* are to be divided where they enter the internal acoustic meatus. The *glossopharyngeal*, the *vagus* and the *accessory nerves* are to be divided just before they enter the jugular foramen. It should be noted that the accessory nerve is joined by filaments from the medulla spinalis. The *hypoglossal nerve* is to be divided where it pierces the dura mater over the hypoglossal canal. Lastly divide the *medulla spinalis* as low down as possible together with the *vertebral arteries*. Then with two fingers of the right hand introduced through the foramen magnum dislodge the medulla oblongata and the cerebellum and take the whole brain out on to the left hand.

Preservation of the Brain.—The brain is next to be hardened. For this purpose a jar of sufficient capacity to contain the brain and preserving fluid and with a properly fitting lid is taken. At the bottom of the jar some tow is placed which serves as a cushion for the brain and preserves its normal contour. A ten per cent. solution of formalin is then poured into the jar sufficient to cover the brain and the padding of tow. Some punctures are made in the membranes covering the brain and then the organ is immersed in the lotion with its base uppermost. The mouth of the jar is then covered by the lid. For ordinary purposes the brain will be well hardened in formalin solution. But for special dissections the brain should be removed from the formalin solution after a week and transferred to another jar containing rectified spirit. The brain lies on a similar pad in this

jar and should be kept in it till the dissection of the head and neck is finished, when the study of the brain is commenced.

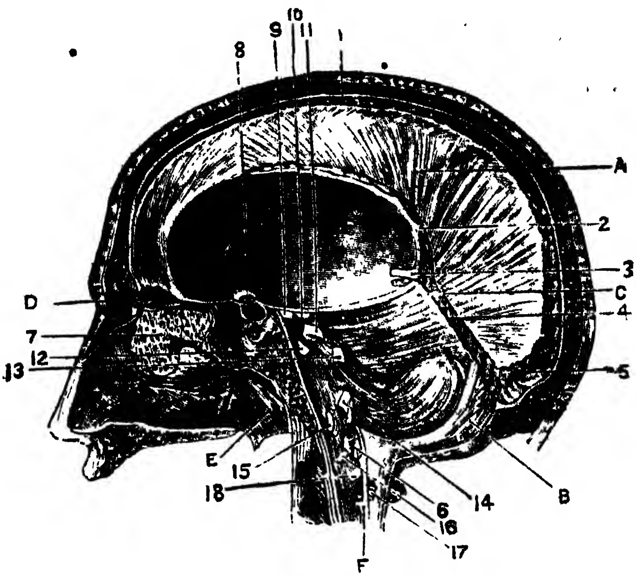


Fig. 49.—Processes and sinuses of the dura mater; exit of the cranial nerves;—sideview (from Hirschfeld and Leveille).

A. Falx cerebri.
B. Falx cerebelli.
C. Tentorium cerebri.
D. Crista galli of ethmoid.
E. Auditory tube.
F. Ligamentum denticulatum.
1. Superior sagittal sinus.
2. Inferior sagittal sinus.
3. Great cerebral vein.
4. Straight sinus.
5. Confluence of sinuses.
6. Vertebral artery.
7. Olfactory nerves.
8. Optic nerve.
9. Oculomotor nerve.
10. Trochlear nerve.
11. Trigeminal nerve.
12. Abducent nerve.
13. Facial and acoustic nerves.
14. Glossopharyngeal, vagus and accessory nerves.
15. Hypoglossal nerve.
16. First cervical nerve.
17. Posterior root of second cervical nerve.
18. Anterior root of second cervical nerve.

Processes of the Dura Mater.—The following are the processes formed by the meningeal layer of the dura mater :—

Vertical { 1. Falx cerebri.
2. Falx cerebelli.

Horizontal { 1. Tentorium cereblli.
2. Diaphragma sellæ.

The **Falx Cerebri** has been already examined.

The **Falx Cerebelli** is a falciform process of the dura mater given off between the hemispheres of the cerebellum. Its base is uppermost being attached to the inferior surface of the tentorium cerebelli at its back part. Its apex divides into two narrow processes which are continued to the sides of the foramen magnum. Its posterior border is convex and is attached to the internal occipital crest and encloses the occipital sinus. Its anterior border is free and lies in the cleft between the two cerebellar hemispheres.

The **Tentorium Cerebelli** is an arched process of the dura mater interposed between the cerebellum below and the posterior part of the cerebrum above. When observed in situ it is almost horizontal, elevated in the centre and gradually sloping down towards the circumferential attachment. Its posterior border or the circumferential attachment is convex and is attached behind to the margins of the transverse sulcus on the inner surface of the occipital bone and to the margins of the groove at the inner aspect of the mastoid angle of the parietal bone. At this attachment it splits to enclose the transverse sinus. Further in front it is attached to the superior border of the petrous portion of the temporal bone and here it splits to enclose the superior petrosal sinus. The anterior border is free and concave. At the apex of the petrous portion of the temporal bone the anterior and

posterior borders meet and cross each other and are prolonged forwards to be attached respectively to the anterior and posterior clinoid processes of the sphenoid. Its superior surface is convex and gives attachment to the falx cerebri in the middle line antero-posteriorly, the straight sinus running along the junction of the two processes of the dura mater. Its inferior surface gives attachment posteriorly to the base of the falx cerebelli.

The **Diaphragma Sellæ** is a circular horizontal fold which retains the pituitary body in the sella turcica. It presents a small opening in the centre through which the infundibulum passes.

The **Sinuses of the Dura Mater** may be arranged as follows :—

A. *Along the medial plane.*	B. *Bilateral.*	C. *Across the medial plane.*
Superior sagittal.	Transverse.	Intercavernous.
Inferior sagittal.	Cavernous.	Basilar plexus.
	Sphenoparietal.	
Straight.	Superior petrosal.	
Occipital.	Inferior petrosal.	

The **Superior Sagittal Sinus** has been already examined.

The **Inferior Sagittal Sinus** (Inferior longitudinal sinus) lies enclosed in the free margin of the falx cerebri at its posterior half or two-thirds. It receives tributaries from the falx cerebri and a few veins from the medial surface of the cerebral hemispheres. It terminates behind at the anterior extremity of the straight sinus.

The **Straight Sinus** passes from before backwards along the tentorial border of the falx cerebri. At the internal occipital protuberance it terminates in one of the

transverse sinuses (usually the left) which does not receive the superior sagittal sinus. Its tributaries are (1) the inferior sagittal sinus, (2) the great cerebral vein which opens at its front and (3) the superior cerebellar veins.

The **Transverse Sinuses** (Lateral sinuses) are two in number, a right and a left. The right one is usually a continuation of the superior sagittal sinus while the left one of the straight sinus. Sometimes the superior sagittal sinus is continued into the left transverse sinus and the straight sinus into the right transverse sinus. At the beginning of the transverse sinus where the superior sagittal sinus opens there is a dilatation called the *confluence of sinuses.* The two transverse sinuses at their commencement communicate with each other by a short transverse venous channel passing in front of the internal occipital protuberance. Each sinus passes lateralwards and forwards lying against the inner surface of the occipital bone and the mastoid angle of the parietal bone along the attached border of the tentorium cerebelli. It then curves downwards and medialwards lying along the sigmoid sulcus of the mastoid portion of the temporal bone. Finally it passes through the posterior compartment of the jugular foramen to become continuous with the internal jugular vein. Its tributaries are (1) some cerebellar veins, (2) a diploic vein and (3) the superior petrosal sinus. It communicates with the extra cranial veins by two emissary veins which pass through the mastoid foramen and the condyloid canal.

The **Occipital Sinus** lies along the posterior border of the falx cerebelli. It begins by small veins around the foramen magnum and opens into the confluence of sinuses. Usually there are two occipital sinuses at the commencement which unite higher up to form a single trunk. Sometimes they remain separate in their entire course and each opens into the transverse sinus of its own side. It

communicates below with the posterior internal vertebral venous plexus.

Cavernous Sinus.—This is a curved sinus so called because its lumen is traversed by intersecting bands. It lies on either side of the body of the sphenoid. It begins in front at the superior orbital fissure where it receives the ophthalmic veins and ends behind at the apex of the petrous portion of the temporal bone in the superior and inferior petrosal sinuses. It communicates with its fellow of the opposite side by the intercavernous sinuses. In addition to the ophthalmic veins the sphenoparietal sinuses open into the cavernous sinuses. Two emissary veins, one passing through the foramen ovale or foramen Vesalii and the other through the foramen lacerum, join the cavernous sinuses. The structures lying in the medial and lateral walls of the sinus will be examined later on.

The **Sphenoparietal Sinus** is a minute venous channel which passes medialwards along the undersurface of the small wing of the sphenoid and opens into the cavernous sinus.

The **Superior Petrosal Sinus** begins at the posterior end of the cavernous sinus and ends in the transverse sinus lying in its course along the superior border of the petrous portion of the temporal bone.

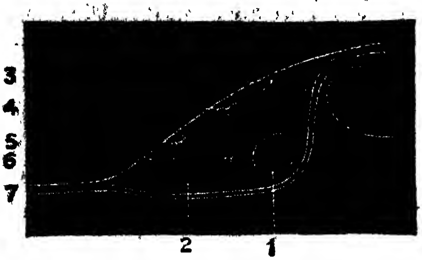
The **Inferior Petrosal Sinus** runs along the groove formed by the articulation of the basilar part of the occipital bone with the posterior border of the petrous portion of the temporal bone. It begins in front in the cavernous sinus and ends behind in the internal jugular vein, after it has passed through the anterior compartment of the jugular foramen.

The **Intercavernous Sinuses** are two in number an anterior and a posterior. They connect the cavernous sinuses, the anterior one passing in front and the posterior one behind the diaphragma sellæ. The two intercaver-

nous sinuses together with the intervening cavernous sinuses form a circular venous channel called the *circular sinus.*

The **Basilar Plexus** consists of minute venous channels between the two layers of the dura mater covering the basilar part of the occipital bone and establishes communication between the inferior petrosal sinuses of the two sides. Below it communicates with the anterior internal vertebral venous plexus.

Exit of the Cranial Nerves.—The dissector has now to examine at the base of the skull the points at which the cranial nerves pierce the dura mater and trace these up to the points where they leave the cranial cavity. As each nerve goes out it receives sheaths from each of the three coverings of the brain. The sheath derived from the arachnoid soon disappears, but those derived from the dura mater and pia mater are gradually lost on the nerve. The *olfactory nerves* are minute filaments about twenty in number which pierce the dura mater over the lamina cribrosa of the ethmoid, through the foramina of which they enter the nasal cavity. They are attached to the inferior surface of the olfactory bulb which has been removed with the brain. The *optic nerve* perforates the dura mater opposite the optic foramen and pass through it to the orbit. It is accompanied by the ophthalmic artery. The oculomotor nerve pierces the dura mater in front of and lateral to the posterior clinoid process. Trace this nerve in the lateral wall of the cavernous sinus to its exit from the cranial cavity through the superior orbital fissure. In the lateral wall of the cavernous sinus it communicates with the cavernous plexus of the sympathetic around the internal carotid artery and with the ophthalmic division of the trigeminal nerve by minute filaments. Before its exit through the superior orbital fissure it subdivides into a superior and an inferior ramus. The *trochlear nerve* pierces the dura mater at the free

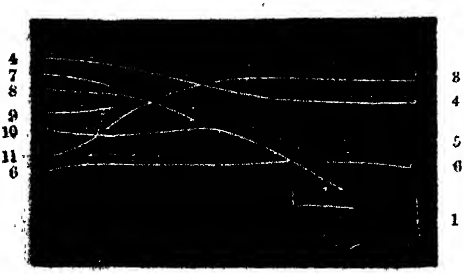


1. Internal carotid artery.
2. Lumen of the cavernous sinus.
3. Oculomotor nerve.
4. Trochlear nerve.
5. Ophthalmic nerve.
6. Abducent nerve.
7. Dura mater.

Fig. 50.—Diagram showing the position of the nerves in the wall of the cavernous sinus.

margin of the tentorium cerebelli behind and lateral to the posterior clinoid process. Traced in the cavernous sinus it is found to lie in its lateral wall between the oculomotor nerve above and the ophthalmic division of the trigeminal nerve below. Here it communicates with the cavernous plexus of the sympathetic and with the ophthalmic division of the trigeminal nerve by minute filaments. Before its exit through the superior orbital fissure it crosses the oculomotor nerve. The *trigeminal*

Superior orbital fissure. *Carotid groove.*



1. Semilunar ganglion.
3. Oculomotor nerve.
4. Trochlear nerve.
5. Ophthalmic division of trigeminal nerve.
6. Abducent nerve.
7. Frontal nerve.
8. Lacrimal nerve.
9. Superior division of oculomotor nerve.
10. Naso-ciliary nerve.
11. Inferior division of oculomotor nerve.

Fig. 51.—Diagram of the nerves passing through the superior orbital fissure and the carotid groove.

nerve consists of a motor and a sensory root. Both the roots pierce the dura mater opposite the apex of the petrous portion of the temporal bone, the motor root lying to the medial side. On cutting through the dura mater and tracing the roots a ganglion, called the semilunar ganglion (Gasserian ganglion), is found on the sensory root. This ganglion lies on the trigeminal impression of the petrous portion of the temporal bone in a cavity (cavum Meckelii) between the two layers of the dura mater. Its convex margin is directed forwards and lateralwards and from it issue the three large nerves viz., the ophthalmic, maxillary and mandibular. Behind the ganglion lies the motor root of the trigeminal nerve. The medial end of the ganglion is joined by filaments from the cavernous plexus of the sympathetic. Trace the three branches of the trigeminal nerve to their exit from the cranial cavity. The *ophthalmic nerve* is the smallest of the three divisions of the trigeminal. It arises from the anteromedial part of the ganglion and passes through the lateral wall of the cavernous sinus lying below the trochlear nerve. Before entering the orbit through the superior orbital fissure it divides into three branches; frontal, nasociliary and lacrimal. In the wall of the sinus it communicates with the oculomotor, trochlear and abducent nerves and is joined by filaments from the cavernous plexus of the sympathetic. It gives off a meningeal branch which supplies the tentorium cerebelli. The student has traced three nerves along the lateral wall of the cavernous sinus and he should note their relative position. The oculomotor nerve is the highest, the ophthalmic nerve the lowest and the trochlear nerve is intermediate in position. The *maxillary nerve* arises from the middle part of the convex border of the semilunar ganglion and passes forwards lateral to the cavernous sinus to the foramen rotundum through which it passes

out of the cranial cavity. It gives off the middle meningeal nerve which supplies the dura mater of the middle fossa of the base of the skull. The *mandibular nerve* (inferior maxillary nerve) is the largest division of the trigeminal. It passes out of the cranial cavity through the foramen ovale and is joined by the motor root of the trigeminal nerve just after its exit through the foramen. The *abducent nerve* pierces the dura mater at the lower part of the dorsum sellæ where a notch exists for it on either side. It passes along the medial wall of the cavernous sinus lateral to the internal carotid artery covered by the lining membrane of the sinus. It enters the orbit through the superior orbital fissure. In the wall of the lateral sinus it communicates with the cavernous plexus of the sympathetic, and with the ophthalmic nerve. The *facial nerve*, the *nervus intermedius* and the *acoustic nerve* leave the cranial cavity through the internal acoustic meatus piercing the dura mater over it. The *glossopharyngeal, vagus* and *accessory nerves* pierce the dura mater over the jugular foramen and pass through its middle compartment. The aperture in the dura mater for the glossopharyngeal nerve is separate and is situated in front. The vagus and accessory nerves have a common aperture in the duramater behind. The *hypoglossal nerve* pierces the dura mater over the hypoglossal canal in two separate bundles which unite together in the canal to form one trunk.

The dissector has now to examine the arteries entering into the cranial cavity. These are :- 1. The internal carotid arteries. 2. The vertebral arteries. 3. The meningeal arteries.

Internal Carotid Artery.—This artery should now be traced from the point it enters the cranial cavity immediately after its exit from the carotid canal at the apex of the petrous portion of the temporal bone. It

pierces the outer layer of the dura mater and passes forwards between its two layers along the medial wall of the cavernous sinus on the side of the body of the sphenoid. It is separated here from the blood of the sinus by its lining membrane. On reaching the medial side of the anterior clinoid process it passes upwards and pierces the inner layer of the dura mater. At this situation the artery has been divided when the brain was removed. The artery is surrounded by the cavernous plexus of the sympathetic. The abducent, oculomotor, trochlear and ophthalmic nerves all lie lateral to it. The branches given off from the cavernous portion of the internal carotid artery are :—(1) *cavernous branches*, which are small twigs and supply the wall of the cavernous sinus, (2) *hypophysial branches* which supply the hypophysis, (3) *semilunar branches* which are small twigs and supply the semilunar ganglion and (4) *anterior meningeal branch* which crosses the small wing of the sphenoid and supplies the dura mater of the anterior fossa of the base of the skull.

The **Vertebral Artery** pierces the dura mater below the foramen magnum and here it has been divided when the brain was removed.

Meningeal Arteries.—These may be classified as follows :—

I. In the anterior cranial fossa

Meningeal branches of { Anterior ethmoidal artery. Posterior ethmoidal artery. Internal carotid artery.

II. In the middle cranial fossa

Middle meningeal artery.
Accessory meningeal artery.
Meningeal branch of ascending pharyngeal artery.

III. In the posterior cranial fossa

Two meningeal branches of ascending pharyngeal artery.

Meningeal branch of occipital artery.

Meningeal branch of vertebral artery.

In the anterior cranial fossa of the base of the skull meningeal branches are given off from the anterior and posterior ethmoidal arteries as they enter the cranium through the anterior and posterior ethmoidal foramina. In addition the anterior meningeal branch of the internal carotid artery has been already noticed. These meningeal branches supply the dura mater and shine through it when the subject is well injected.

Detach the dura mater carefully from the middle cranial fossa beginning at the cut margin of the skull and reflect it towards the foramen spinosum in the sphenoid through which the middle meningeal artery enters the cranial cavity. Note that the dura mater is firmly attached to the bones at the base of the skull and specially opposite the sutures.

In the middle cranial fossa the largest of the meningeal arteries viz., the **Middle Meningeal Artery,** is seen. It is a branch of the internal maxillary artery, and enters the cranial cavity through the foramen spinosum. On the great wing of the sphenoid it divides into an anterior and a posterior branch. The *anterior branch*, the larger, passes along the great wing of the sphenoid and ascends along the groove on the inner surface of the sphenoidal angle of the parietal bone and divides into branches which supply the dura mater as far as the vertex of the skull and also the occipital region. The *posterior branch* runs upwards and backwards grooving the squamous part of the temporal bone and the squamous border of the parietal bone and supplies the posterior part of the dura

mater. The branches given off from the middle meningeal artery within the cranial cavity are: (1) *ganglionic branches* which supply the semilunar ganglion and (2) *superficial petrosal branch* which enters the hiatus of the facial canal and supplies the facial nerve and the tympanic cavity. The *middle meningeal vein* leaves the cranial cavity through the foramen spinosum to open into the pterygoid plexus of veins. The *accessory meningeal artery* (small meningeal artery) is a branch of the internal maxillary artery or of its middle meningeal branch. It enters the cranial cavity through the foramen ovale and supplies the dura mater and the semilunar ganglion. A *meningeal branch* of the ascending pharyngeal artery enters through the foramen lacerum and supplies the dura mater of the middle cranial fossa.

In the posterior fossa of the base of the skull two meningeal branches of the ascending pharyngeal artery are seen. One enters the cranial cavity through the jugular foramen and the other through the hypoglossal canal. A meningeal branch of the occipital artery enters the cranial cavity through the jugular foramen. The meningeal branch of the vertebral artery enters the cranial cavity through the foramen magnum. All these meningeal branches supply the dura mater of the posterior fossa of the base of the skull.

The cavernous plexus of the sympathetic and some minute nerves entering the middle cranial fossa are now to be examined.

The *cavernous plexus of the sympathetic* surrounds the internal carotid artery specially on its lower and medial side when it traverses the medial wall of the cavernous sinus. It is the continuation upwards of the sympathetic plexus lying on the medial side of the internal carotid artery in the carotid canal. It sends communicating filaments to the oculomotor, trochlear, ophthalmic and

abducent nerves and supplies the sympathetic root of the ciliary ganglion in the orbit.

The *greater superficial petrosal nerve* will be seen lying beneath the semilunar ganglion. It has its origin from the genicular ganglion of the facial nerve and issues out of the petrous portion of the temporal bone through the hiatus of the facial canal. The petrosal branch of the middle meningeal artery also passes through this canal. The nerve enters the cartilaginous substance filling the foramen lacerum and unites in it with the deep petrosal nerve to form the nerve of the pterygoid canal.

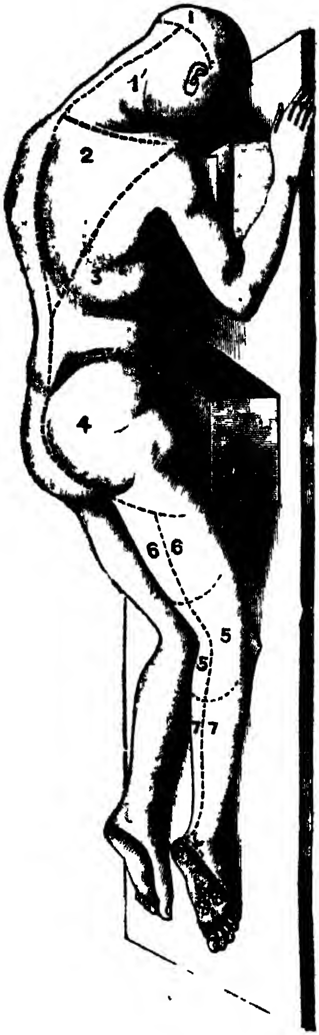
The *deep petrosal nerve* is a branch of the carotid plexus of the sympathetic. It issues out of the carotid canal along the lateral side of the internal carotid artery and joins the greater superficial petrosal nerve in the foramen lacerum to form the nerve of the pterygoid canal.

The *lesser superficial petrosal nerve* is formed by a filament from the genicular ganglion of the facial nerve joining the tympanic branch of the glossopharyngeal. It issues out of the petrous portion of the temporal bone through a slit just lateral to the hiatus of the facial canal. It leaves the cranial cavity through a slit between the petrous portion of the temporal bone and the great wing of the sphenoid, or through the foramen ovale to join the otic ganglion.

Nervus spinosus. This minute nerve is a branch of the mandibular nerve outside the cranial cavity. It will be seen entering the cranial cavity through the foramen spinosum accompanying the middle meningeal artery and supplying the dura mater.

THE DISSECTION OF THE BACK.

On the fourth day the body is turned so that it lies on its face. The subject is allowed to remain in this position for four days. During the first two days the dissector



1. Dissection of scalp.

1′. of back of neck.

2,3. of back.

4. of gluteal region.

6. of back of thigh

5. of popliteal space.

7. of back of leg.

8. of sole of foot.

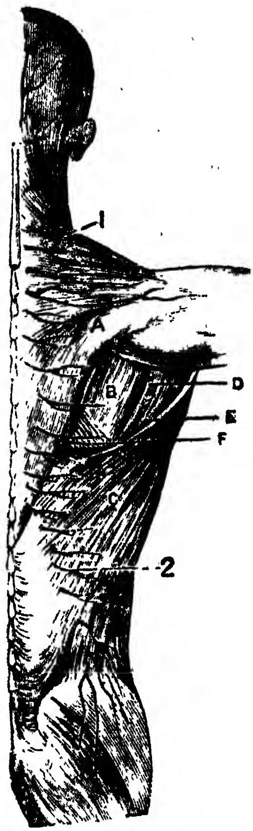
Fig. 52.—Posterior view of the body showing the lines of incisions for reflecting the integument.

of the head and neck dissects in conjunction with the dissector of the superior extremity till the muscles of the second layer are reflected.

Incisions.—Make a longitudinal incision from the external occipital protuberance to the tip of the spinous process of the seventh cervical vertebra. From the lower end of this incision give a transverse incision to the acromio-clavicular articulation. Reflect the skin laterally. (Fig. 52).

The **Superficial Fascia** is fatty and is a portion of the superficial fascia covering the whole body. In it the cutaneous vessels and nerves ramify.

The **Cutaneous Nerves** are to be searched for in the superficial fascia. They are the medial branches of the posterior divisions of the cervical nerves. The posterior division of the first cervical nerve usually gives off no



A. Trapezius.
B. Infraspinatus.
C. Latissimus dorsi.
D. Teres minor.
E. Teres major.
F. Rhomboideus major.
1. Cutaneous nerve (medial branch)
2. Cutaneous nerve (lateral branch)

Fig. 53.—Dissection showing the superficial muscles and cutaneous nerves of the back (after Cunningham). In the upper part the medial branches of the posterior divisions of the spinal nerves are cutaneous; in the lower part their lateral branches are cutaneous.

cutaneous branch. The medial branch of the posterior division of the second cervical nerve is called the *great occipital nerve*. It pierces the trapezius near its attachment to the occipital bone and becomes cutaneous. Its termination has been noticed during the dissection of the scalp. The medial branch of the posterior division of the third cervical nerve is called the *third occipital nerve*. It pierces the trapezius and becomes cutaneous, medial to the great occipital nerve. It supplies the skin of the lower and back part of the head close to the medial line. The medial branches of the posterior division of the fourth and fifth cervical nerves pierce the trapezius lower down close to the spinous processes; those of the lower three cervical nerves do not become cutaneous.

The *deep fascia* is a portion of the fascia colli and is very dense. At the lateral border of the trapezius it splits to enclose the muscle.

Muscles of the Back.—The following table shows the arrangement in layers of the muscles of the back and the work assigned to the dissectors of head and neck and superior extremity:

First layer	Trapezius.	Dissectors of head and neck and superior extremity.
	Latissimus dorsi.	Dissector of superior extremity.
Second layer	Rhomboidei.	
	Splenius colli and capitis. Serratus posterior superior and inferior.	Dissector of head and neck.
	Levator scapulæ. Inferior belly of omohyoid.	Dissectors of head and neck and superior extremity.

Third layer	Sacro-spinalis and its prolongations. Semispinalis capitis.	Dissector of head and neck.
Fourth layer	Multifidus. Rotatores. Interspinales. Intertransversarii. Levatores costarum. Rectus capitis posterior major. Rectus capitis posterior minor. Obliquus capitis superior. Obliquus capitis inferior.	

Trapezius.—This muscle is now to be cleaned. Remove the superficial layer of the deep fascia from its surface. Its lower portion below the level of the seventh cervical spine must be cleaned by the dissector of the superior extremity. The whole work at the trapezius should be done in conjunction with him. The muscle is triangular in shape and arises from (1) the medial third of the superior nuchal line of the occipital bone, (2) the external occipital protuberance, (3) the ligamentum nuchæ, (4) (4) the tip of the spinous process of the seventh cervical vertebra, and (5) the spinous processes of all the thoracic vertebræ and the supraspinous ligaments connecting them. The upper fibres pass obliquely downwards and lateralwards, the middle fibres horizontally, and the lower fibres upwards and lateralwards. It is inserted (1) into the posterior border of the lateral third of the clavicle by its upper fibres, (2) into the medial border of the acromion process and the upper lip of the posterior border of the spine of the scapula by its middle fibres and (3) into the

tubercle at the commencement of the spine of the scapula by its lower fibres ending in an aponeurosis which glides over the smooth triangular surface at the apex of the spine of the scapula. The upper free border of the muscle forms the posterior boundary of a triangular space called the posterior triangle of the neck.

Nerve-supply.—It is supplied by the accessory nerve and the third and fourth cervical nerves.

Reflect the trapezius by dividing it at its occipital origin and half an inch lateral to the ligamentum nuchæ and throw it lateralwards in conjunction with the dissector of the superior extremity. While reflecting the muscle note the process of the fascia colli which passes beneath it. The accessory nerve and branches from the third and fourth cervical nerves are seen to enter its deep surface. The ascending branch of the transverse cervical artery is seen to pass upwards beneath the muscle. The following muscles are now exposed:—the levator scapulæ, the inferior belly of the omo-hyoid, the rhomboidei major and minor, the serratus posterior superior and inferior, and the splenius capitis.

The **Levator Scapulæ** (Levator anguli scapulæ) arises from the posterior parts of the transverse processes of the first and second cervical vertebræ and from the posterior tubercles of the transverse processes of the third and fourth cervical vertebræ. It is inserted into the vertebral border of the scapula between its medial angle and the triangular smooth surface at the apex of the spine. It is supplied by branches from the anterior divisions of the third and fourth cervical nerves which enter its superficial surface. It usually gets a branch from the dorsal scapular nerve which passes beneath it.

The inferior belly of the **Omohyoideus** arises from the superior transverse ligament of the scapula and the adjacent upper border of the scapula.

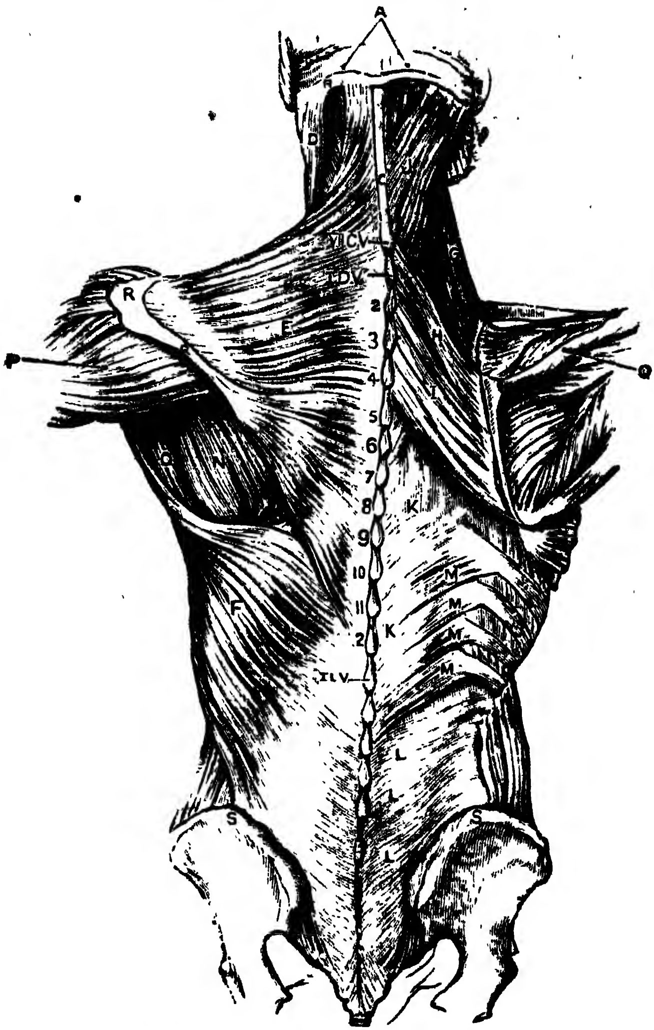


Fig. 54.—Muscles of the back (modified from Gray). The first layer of muscles in seen on the left side and the second and third layers, on the right side.

A. Occipital bone.
B. Superior nuchal line.
C. Ligamentum nuchæ.
D. Sterno-cleido-mastoideus.
E. Trapezius.
F. Latissimus dorsi.
G. Levator scapulæ.
H. Rhomboideus minor.
I. Rhomboideus major.
J. Splenius capitis et colli.
K. Lumbodorsal fascia (thoracic portion).
L. Lumbodorsal fascia (lumbar portion)
M. Serratus posterior inferior.
N. Infraspinatus.
O. Teres major.
P. Deltoideus.
Q. Spine of scapula.
R. Acromion.
S. Crest of ilium.

The dissector should now observe that the transverse scapular artery passes over the superior transverse scapular ligament and that the suprascapular nerve passes through the scapular notch below the ligament. The ascending branch of the transverse cervical artery (superficial cervical artery) passes upwards between the trapezius and the splenius and anastomoses with the superficial branch of the descending ramus of the occipital artery. The descending branch of the transverse cervical artery (posterior scapular artery) passes beneath the levator scapulæ to the medial angle of the scapula and descends along its vertebral border to its inferior angle. This artery will be traced by the dissector of the superior extremity.

The **Serratus Posterior Superior** is a thin quadrilateral muscle which arises by an aponeurosis (1) from the lower part of the ligamentum nuchæ and (2) from the spinous processes of the seventh cervical and upper two or three thoracic vertebræ. It passes downwards and lateralwards and is inserted by digitations into the outer surfaces of the second, third, fourth and fifth ribs in front of their angles. It is supplied by the intercostal nerves.

The **Serratus Posterior Inferior** arises by an aponeurosis (1) from the spinous processes of the last two thoracic and upper two lumbar vertebræ and (2) from the supraspinous ligaments. This aponeurotic origin is blended with the lumbodorsal fascia. It is inserted by digitations into the outer surfaces of the lower four ribs

a little in front of their angles. It is supplied by the intercostal nerves.

The **Lumbodorsal Fascia** covers the deep muscles of the back and consists of a thoracic and a lumbar portion.

The *thoracic portion of the lumbodorsal fascia* (Vertebral aponeurosis) is thin but strong and is attached laterally to the angles of the ribs and medially to the spinous processes of the thoracic vertebræ. These attachments can be verified by making a longitudinal incision along the middle of the fascia and introducing the handle of the scalpel both medially and laterally. Traced above the fascia is seen to pass beneath the serratus posterior superior to become continuous with the deep fascia of the neck. Below it is continuous with its lumbar portion.

The *lumbar portion of the lumbodorsal fascia* (Lumbar fascia) is thick and strong and consists of three lamellæ viz., a posterior, a middle and an anterior.

At present the *posterior lamella* covering the sacrospinalis is seen. It is blended superficially with the aponeurotic origin of the latissimus dorsi and the serratus posterior inferior. Above it is continuous with the thoracic portion of the fascia. Below it is attached to the outer lip of the iliac crest and to the posterior surface of the sacrum and coccyx. Medially it is attached to the spinous processes of the lumbar and sacral vertebræ. Laterally it gives origin to the transversus abdominis. From its anterior surface at the lateral edge of the sacrospinalis it sends off medialwards the middle lamella of the fascia.

To display the *middle lamella* make a longitudinal incision in the posterior lamella a little medial to the lateral edge of the sacrospinalis from the last rib to the iliac crest. From the upper and lower ends of this incision give a transverse incision medially towards the spinous

processes. Reflect the quadrilateral flap of the posterior lamella medialwards. The sacrospinalis is now exposed. Raise the lateral edge of the sacrospinalis. The middle lamella lying in front of the muscle is now seen. The middle lamella is attached medially to the tips of the

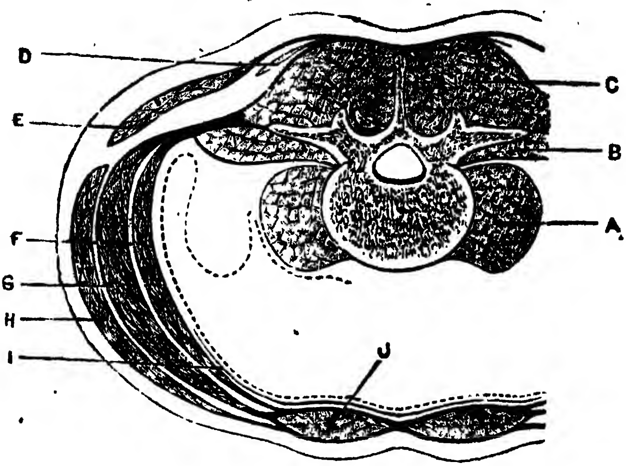


Fig. 55.—Diagram to illustrate the connections of the lumbodorsal fascia (after Cunningham).

A. Psoas major.
B. Quadratus lumborum.
C. Sacrospinalis.
D. Serratus posterior inferior.
E. Latissimus dorsi.
F. Transversus abdominis.
G. Obliquus internus abdominis.
H. Obliquus externus abdominis.
I. Fascia transversalis.
J. Rectus abdominis.

transverse processes of the lumbar vertebræ. Laterally it blends with the posterior lamella at the lateral margin of the sacrospinalis. Above it is attached to the last rib and below to the iliolumbar ligament.

To display the *anterior lamella* divide the middle lamella longitudinally at the lateral edge of the sacro spinalis. The posterior surface of the quadratus lumborum

is exposed. Introduce the finger through this incision and carry it along the lateral edge of the quadratus lumborum. On raising the muscle a little the anterior lamella is seen. The anterior lamella or fascia of the quadratus lumborum is attached medially to the anterior surfaces of the roots of the transverse processes of the lumbar vertebræ. Laterally it blends with the posterior lamella at the lateral edge of the quadratus lumborum. Above it forms a thickened band called the *lateral lumbocostal arch* (p. 92). Below it is attached to the iliolumbar ligament.

The student should note that the three lamellæ of the lumbar portion of the lumbodorsal fascia unite at the lateral margins of the sacrospinalis and the quadratus lumborum and form two compartments, an anterior which lodges the quadratus lumborum and a posterior, the sacrospinalis.

Divide the serratus posterior superior close to its origin from the spinous processes and reflect it lateralwards. Note the branches of the intercostal nerves entering its deep surface.

The **Splenius** is a single muscle at its origin but soon divides into two portions, a cervical portion called splenius cervicis and a cranial portion called splenius capitis. It arises (1) from the lower half of the ligamentum nuchæ and (2) the spinous processes of the seventh cervical and upper six thoracic vertebræ. The *splenius cervicis* is inserted into the tubercles of the transverse processes of the upper two or three cervical vertebræ. The *splenius capitis* is inserted under cover of the sterno-cleido-mastoideus (1) into the lower part of the mastoid portion of the temporal bone and (2) into the occipital bone below the lateral part of the superior nuchal line.

Reflect the splenius muscle upwards and lateralwards towards the cranium by dividing it at its origin. Preserve

the nerves piercing the muscle. Remove the thoracic portion of the lumbodorsal fascia together with the insertion of the serratus posterior inferior and the remains of the posterior lamella of its lumbar portion.

The **Sacrospinalis** (Erector spinæ) is a single fleshy mass at its origin in the sacral and lumbar regions. It arises (1) from the spinous processes of all the lumbar vertebræ and the corresponding supraspinous ligaments, (2) from the middle and lateral sacral crests, (3) from the posterior sacroiliac ligament, (4) from the posterior part of the inner lip of the iliac crest and (5) from the anterior surface of the posterior lamella of the lumbodorsal fascia. Traced upwards the fleshy mass becomes differentiated into three columns, a lateral, an intermediate and a medial. The lateral column separates itself in the upper lumbar region while the medial column, in the upper thoracic region. The lateral column is called the iliocostalis; the intermediate column, the longissimus; and the medial column, the spinalis.

The **Iliocostalis** (Sacrolumbalis) is prolonged upwards into the neck and is separable into three portions according to its situation, viz., iliocostalis lumborum, iliocostalis dorsi and iliocostalis cervicis.

The *iliocostalis lumborum* is inserted by six or seven tendinous slips into the angles of the lower six or seven ribs.

The *iliocostalis dorsi* (Accessorius) arises by six or seven tendinous slips from the angles of the lower six or seven ribs just medial to and covered by the tendons of insertion of the iliocostalis lumborum. It is inserted by separate tendinous slips into the angles of the upper six ribs and into the back part of the transverse process of the seventh cervical vertebra.

The *ilicostalis cervicis* (Cervicalis ascendens) arises by tendinous slips from the angles of the third, fourth,

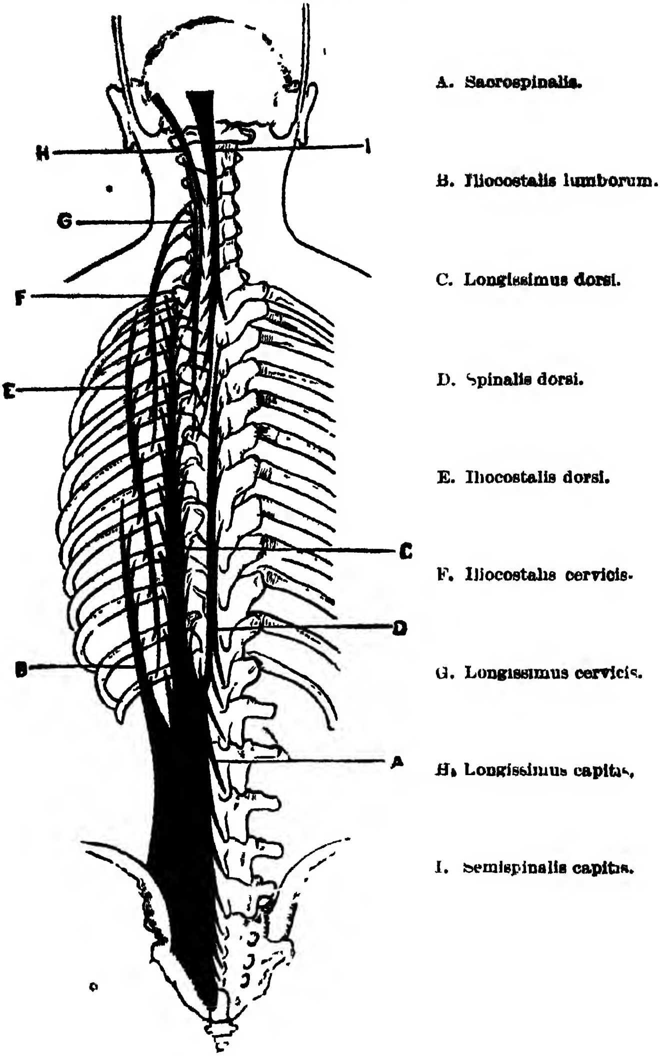


Fig. 56.—Diagrammatic representation of the different portions of the sacrospinalis muscle (modified from Cunningham).

fifth and sixth ribs just medial to the tendons of insertion of the iliocostalis dorsi. It is inserted into the posterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ.

The **Longissimus** is prolonged upwards into the head and is separable into three portions according to their situation, viz., longissimus dorsi, longissimus cervicis and longissimus capitis.

The *longissimus dorsi* is inserted medially by tendinous slips into the transverse processes of the thoracic vertebræ and into the accessory processes of the lumbar vertebræ. Laterally it is inserted into the lower nine or ten ribs in the intervals between their tubercles and angles, and into the transverse processes of the lumbar vertebræ and to the posterior surface of the middle lamella of the lumbo-dorsal fascia.

The *longissimus cervicis* (Transversalis colli) is the prolongation upwards of the longissimus dorsi into the neck. It arises by tendinous slips from the tips of the transverse processes of the upper four thoracic vertebræ medial to the insertion of the longissimus dorsi and is inserted by similar tendinous slips into the posterior tubercles of the transverse processes of all the cervical vertebræ except the first and the last.

The *longissimus capitis* (Trachelo-mastoid) is the prolongation upwards of the longissimus cervicis on to the skull. It arises (1) from the transverse processes of the upper four thoracic vertebræ and (2) from the articular processes of the lower four cervical vertebræ. It is inserted into the mastoid portion of the temporal bone beneath the insertion of the splenius capitis and sterno-cleido-mastoideus.

The **Spinalis** is the medial column of the sacrospinalis. It is separable into two portions, spinalis dorsi and spinalis cervicis. The *spinalis dorsi* is not distinctly

demarcated from the longissimus dorsi lying lateral to it. It arises from the spinous processes of the upper two lumbar and lower two thoracic vertebræ and is inserted into the spinous processes of the upper thoracic vertebræ, the number varying from four to eight. It is blended with the semispinalis dorsi lying beneath it. The *spinalis cervicis* is not constant. When present it arises from the spinous processes of the fifth, sixth and seventh cervical vertebræ and occasionally also from those of the first and second thoracic vertebræ and is inserted into the spinous process of the second and sometimes also into those of the third and fourth cervical vertebræ.

The **Semispinalis Capitis** (Complexus) is not a prolongation of the sacrospinalis but is a separate muscle superadded in the neck. It arises by tendinous slips from the transverse processes of the upper six thoracic vertebræ, and from the articular processes of the fourth, fifth and sixth cervical vertebræ. It is inserted into an impression between the superior and inferior nuchal lines of the occipital bone close to the medial nuchal line. The medial part is more or less separate from the remainder of the muscle and presents two fleshy bellies and an intermediate tendon ; hence, it is called the *biventer cervicis*.

Divide the longissimus capitis at its middle and reflect the upper part as far upwards as possible with the splenius capitis. The second part of the occipital artery is now seen.

The **Occipital Artery** in this part of its course emerges from underneath the posterior margin of the sterno-cleido-mastoideus. Beneath the origin of the sterno-cleido-mastoideus the artery is covered in addition by the longissimus capitis and the splenius capitis which have been reflected. From the posterior margin of the sterno-cleido-mastoideus it crosses the interval between it and the lateral border of the trapezius, passes beneath the latter

muscle and finally pierces it near its origin from the superior nuchal line lateral to the external occipital protuberance. In its course it crosses the origin of the semispinalis capitis. Two or three lymph glands accompany this portion of the artery. They are called the *occipital lymph glands* which drain lymph from the occipital area of the scalp. Their efferents pass to the superior deep cervical lymph glands. The branches given off from the occipital artery here are :— (1) The *descending branch* (arteria princeps cervicis) which passes downwards to the lateral border of the semispinalis capitis and divides into a superficial and a deep branch. The superficial branch descends between the splenius capitis and the semispinalis, supplies these muscles and anastomoses with the ascending branch of the transverse cervical artery. The deep branch descends under cover of the semispinalis capitis to anastomose with the arteria profunda cervicis, a branch of the costocervical trunk. This anastomosis will be seen when the semispinalis capitis will be reflected. (2) The *meningeal branch*, a small twig, which enters the cranial cavity through the mastoid foramen to supply the dura mater of the posterior cranial fossa. (3) *Muscular branches* which supply the neighbouring muscles. The *occipital veins* open into the vertebral and deep cervical veins. Occasionally one of the veins accompanies the artery and opens into the internal jugular vein. An emissary vein usually connects it with the transverse sinus through the mastoid foramen.

Divide the semispinalis capitis at its insertion into the occipital bone and reflect it with care laterally. Note that it is pierced by the medial branches of the posterior divisions of the cervical nerves. Of these the greater occipital nerve is of large size and supplies the muscle with a branch. The anastomosis between the descending branch of the occipital artery and the arteria profunda cervicis is now exposed. The suboccipital triangle is

also brought into view. Remove the spinalis dorsi to expose the semispinalis dorsi lying underneath.

The **Semispinalis Dorsi** arises from the transverse processes of the sixth, seventh, eighth, ninth and tenth thoracic vertebræ and is inserted into the spinous processes of the upper four thoracic and lower two cervical vertebræ.

The **Semispinalis Cervicis** arises from the transverse processes of the upper five thoracic vertebræ and is inserted into the spinous processes of the cervical vertebræ from the second to the fifth inclusive.

Cut the semispinalis dorsi and cervicis at their insertion into the spinous processes of the vertebræ and throw them lateralwards. Detach the sacrospinalis from the sacral and lumbar spinous processes and throw it lateralwards. The multifidus is now fully exposed.

The **Multifidus** arises (1) from the back of the sacrum as low as the fourth posterior sacral foramen, (2) from the overlying aponeurosis of the sacrospinalis, (3) from the posterior sacroiliac ligament, (4) from the posterior superior iliac spine, (5) from the mamillary processes of all the lumbar vertebræ, (6) from the transverse processes of all the thoracic vertebræ, and (7) from the articular processes of the lower four cervical vertebræ. The muscular slips pass upwards and medialwards and are inserted into whole length of the spinous processes of all the lumbar, thoracic and cervical vertebræ except the atlas. The superficial fasciculi skip over two or three vertebræ before their insertion. The deep fasciculi run from one vertebra to the second or third above.

The **Rotatores** are short muscular slips exposed on reflecting the multifidus. They are eleven in number on each side. Each arises from the upper and back part of the root of a transverse process in the thoracic region, beginning from the second thoracic, and becomes inserted

into the lower border and lateral surface of the lamina of the vertebra above.

The **Interspinales** are short muscular fasciculi placed in pairs between the contiguous spinous processes in the cervical and lumbar regions. In the upper and lower thoracic regions they are poorly developed and are altogether absent in the midthoracic region. In the lumbar region they are well marked and placed on either side of the interspinous ligament.

The **Intertransversarii** lie between the transverse processes. In the lumbar region they are well developed and are arranged in two sets : the *intertransversarii laterales* passing between the transverse processes ; the *intertransversarii mediales* extending from the accessory process of the vertebra above to the mamillary process of the vertebra below. In the thoracic region they are absent in the upper part and poorly developed between the lower three or four transverse processes. In the cervical region they exist in pairs between the anterior and posterior segments of the transverse processes.

Remove the remains of the iliocostalis and longissimus from the thoracic region without injuring the blood vessels and nerves.

Levatores Costarum.—These are twelve fan-shaped muscles arising by their apices from the tips of the transverse processes of the seventh cervical and the upper eleven thoracic vertebræ. Each is inserted by a broad base into the rib below between its tubercle and angle.

Nerve-supply.—All these deep muscles of the back are supplied by the posterior divisions of the spinal nerves.

Vessels of the Back.—(1) In the cervical region these are :—(1) the *occipital artery* with its branches which has been examined. (2) The *arteria profounda cervicis* which is a branch of the costocervical trunk. It appears at the back part of the neck between the transverse process of

the seventh cervical vertebra and the neck of the first rib and ascends between the semispinalis capitis and semispinalis cervicis to anastomose with the descending branch of the occipital artery. Its companion vein begins in the suboccipital venous plexus and opens into the vertebral vein. (3) Minute *muscular branches* from the vertebral artery supply the muscles at the back part of the neck. (4) A part of the *vertebral artery* will be seen in the suboccipital triangle (p. 267).

(II) In the thoracic region the arteries are derived from the posterior branches of the *intercostal arteries*. They accompany the posterior branches of the intercostal nerves and supply the muscles and skin of the back. The companion veins open into the intercostal veins.

(III) In the lumbar region the arteries are derived from the posterior branches of the *lumbar arteries* and have a similar distribution. Their companion veins open into the lumbar veins.

(IV) In the sacral region the arteries are derived from the terminal branches of the *lateral sacral arteries* which emerge from the posterior sacral foramina and are accompanied by the posterior divisions of the sacral nerves. They supply the neighbouring muscles. The companion veins open into the lateral sacral veins.

Nerves of the Back.—These are derived from the posterior divisions of the spinal nerves. They appear at the back between the transverse processes in the cervical, thoracic and lumbar regions. There are thirty-one pairs of spinal nerves and with the exception of four nerves (the first cervical, the fourth and fifth sacral and the coccygeal) each posterior division divides into a medial and a lateral branch. As a general rule it may be said that the medial branches down to the posterior division of the sixth thoracic spinal nerve supply muscles and then become cutaneous to supply the skin ; whereas the

lateral branches of these nerves are exhausted in supplying the muscles and do not become cutaneous. Below that the condition is reversed, viz., the lateral branches supply the muscles and integument as well; whereas the medial branches are exhausted in supplying the muscles only and do not become cutaneous.

(I) *Posterior divisions of the cervical nerves.*—The posterior division of the *first cervical* or *suboccipital nerve* is purely muscular and will be studied during the dissection of the suboccipital triangle. The posterior division of the second cervical nerve is very large. Its medial branch is very long and is called the *great occipital nerve* which has been seen to pierce the semispinalis capitis and trapezius and supply the skin of the scalp. Its lateral branch supplies the splenius, longus capitis, and semispinalis capitis. The medial branch of the posterior division of the *third cervical nerve* gives off a cutaneous branch called the *third occipital nerve* which ascends to the scalp medial to the great occipital nerve; its lateral branch joins with that of the second cervical. The medial branches of the *fourth* and *fifth cervical nerves* become cutaneous by piercing the trapezius near the spinous processes; those of the *sixth, seventh* and *eighth cervical nerves* are exhausted in supplying the muscles and do not become cutaneous. The lateral branches of the posterior divisions of the lower five cervical nerves supply the neighbouring muscles and no not become cutaneous.

(II) *Posterior divisions of the thoracic nerves.*—The medial branches of the upper six thoracic nerves supply the multifidus and sacrospinalis and become cutaneous by piercing the trapezius near the spinous processes; those of the lower six nerves are exhausted in supplying the multifidus. The lateral branches of the upper six thoracic nerves supply the lateral and intermediate pro-

longations of the sacrospinalis and do not become cutaneous; those of the lower six nerves supply the muscles and become cutaneous by emerging in a line with the angles of the ribs.

(III) *Posterior divisions of the lumbar nerves.*—The medial branches of these nerves supply the multifidus. The lateral branches of the upper three nerves are large. They supply the sacrospinalis, pierce the posterior lamella of the lumbodorsal fascia and descend across the iliac crest to become cutaneous in the gluteal region. The lateral branches of the fourth and fifth lumbar nerves supply the muscles and give off no cutaneous branches.

(IV) *Posterior divisions of the sacral nerves.*—Those of the upper three emerge from the posterior sacral foramina and divide into medial and lateral branches. The medial branches are lost in the multifidus. The lateral branches form loops with each other. From these loops twigs are given off which pierce the sacrotuberous ligament and the gluteus maximus to supply the skin of the gluteal region. The posterior division of the fourth sacral nerve emerges from the fourth posterior sacral foramen, while that of the fifth sacral nerve, from the lower end of the sacral canal. These two nerves do not divide into medial and lateral branches but communicate with each other and with the third sacral above and the coccygeal nerve below. They supply the skin over the lower part of the sacrum and the back of the coccyx.

(V) The *posterior division of the coccygeal nerve* emerges from the lower end of the sacral canal and does not divide into a medial and a lateral branch. It communicates with the fifth sacral nerve above and supplies the back of the coccyx.

The *posterior external vertebral venous plexus* is a network of veins situated on the external surfaces of the laminæ, the spinous, the articular and the transverse proces-

ses of the vertebræ. The student will notice some of these venous channels beneath the multifidus. This plexus receives blood from the skin and muscles of the back,

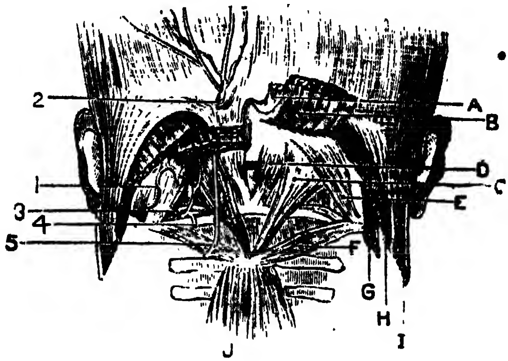


Fig. 57.—Dissection of the suboccipital triangle (from J. T. Gray).

A. Trapezius.
B. Semispinalis capitis.
C. Rectus capitis posterior major.
D. Rectus capitis posterior minor.
E. Obliquus capitis superior.
F. Obliquus capitis inferior.
G. Longissimus capitis.
H. Splenius capitis.
I. Sterno-cleido-mastoideus.
J. Semispinalis colli.
1. Occipital artery.
2. Occipital artery and great occipital nerve.
3. Vertebral artery.
4. Suboccipital nerve.
5. Great occipital nerve.

and ends in the intercostal veins in the thoracic region, in the lumbar veins in the lumbar region, and in the vertebral veins in the cervical region.

The **Ligamentum Nuchæ** is a triangular fibrous partition interposed in the middle line of the neck between the muscles of the two sides. Its apex is attached to the spinous process of the seventh cervical vertebra; its base to the external occipital protuberance and to the median nuchal line. Its anterior border is attached to the posterior tubercle of the atlas and the spinous processes of

the remaining cervical vertebræ. Its posterior border is the continuation upwards of the supraspinous ligament from the spinous process of the seventh cervical vertebra to the external occipital protuberance.

The **Suboccipital Triangle** is a triangular space *bounded* above and medially by the rectus captis posterior major; above and laterally by the obliquus capitis superior; and below by the obliquus capitis inferior. Its *roof* has been seen to be formed by the semispinalis capitis. Its *floor* is formed by the posterior arch of the atlas and the posterior atlanto-occipital membrane. Its *contents* are the vertebral artery and the posterior division of the suboccipital nerve.

The **Rectus Capitis Posterior Major** arises from the spinous process of the epistropheus (Axis) and is inserted into the lateral part of the inferior nuchal line of the occipital bone and to the surface of the bone below it.

The **Obliquus Capitis Inferior** arises from the spinous process of the epistropheus and is inserted into the lower and back part of the transverse process of the atlas.

The **Obliquus Capitis Superior** arises from the upper and back part of the transverse process of the atlas and is inserted into the occipital bone between the superior and inferior nuchal lines and lateral to the insertion of the semispinalis capitis.

The **Rectus Capitis Posterior Minor** lies on the medial side of the rectus capitis posterior major. It arises from the tubercle on the posterior arch of the atlas and is inserted into the medial part of the inferior nuchal line of the occipital bone and to the surface of bone below it.

Nerve-supply.—All these muscles are supplied by the posterior division of the suboccipital nerve.

Trace any of these muscular twigs towards its origin and it will lead to the posterior division of the suboccipital nerve lying on the posterior arch of the atlas and beneath

the vertebral artery. This artery will be seen lying in the sulcus behind the superior articular process of the atlas.

Vertebral Artery.--A small portion of the artery is exposed in the suboccipital triangle as it passes from the foramen in the transverse process of the atlas backwards and medialwards. Here it lies on the sulcus arteria vertebralis of the atlas, the posterior division of the suboccipital nerve lying between the artery and the sulcus in the bone. It passes through the gap between the lateral margin of the posterior atlanto-occipital membrane and the superior articular process of the atlas, pierces the dura mater and enters the vertebral canal.

The **Posterior division of the Suboccipital Nerve** emerges from beneath the vertebral artery as it lies on the sulcus on the posterior arch of the atlas. It does not divide into medial and lateral branches but at once breaks up into branches which supply the three muscles forming the boundaries of the suboccipital triangle and also the rectus capitis posterior minor and semispinalis capitis.

The dissector has now to lay open the whole of the vertebral canal from behind. For this purpose the laminæ and spinous processes of the vertebræ are to be cleaned throughout the whole length of the vertebral column by removing the remains of the multifidus and rotatores. The posterior divisions of the spinal nerves are to be thrown laterally. The laminæ are then to be sawn through just medial to the articular processes commencing from the laminæ of the third cervical vertebra to those of the sacrum. The saw is to be used a little obliquely with the cutting edge turned slightly medialwards. When using the saw in any region that particular region should be made tense by placing a block underneath. The neck is made tense by allowing the head to hang over the edge of the table. In the lumbar region it is convenient to use the chisel and hammer. The laminæ with the inter-

vening ligamenta flava are then removed in one mass. The dura mater of the medulla spinalis is now exposed covered by some loose areolar tissue and fat in which are seen embedded minute arteries and plexuses of veins.

The *ligamenta flava* (Ligamenta subflava) fill up the gap between the adjacent laminæ. Each ligament is attached above to the lower margin and the adjacent anterior surface of the lamina of the upper vertebra and below to the upper margin and the adjacent posterior surface of the lamina of the lower vertebra. Laterally it is continuous with the articular capsule and medially it is fused with the ligament of the opposite side leaving gaps for the exit of small veins from the interior of the vertebral canal. These ligaments are broad in the cervical and lumbar regions and are composed of yellow elastic tissue.

The *interspinous ligaments* extend between the contiguous margins of the spinous processes of adjacent vertebræ. Each ligament is continuous in front with the ligamenta flava and behind with the supraspinous ligament. These ligaments are well developed in the lumbar region and are weak in the cervical and thoracic regions.

The *supraspinous ligaments* extend between the tips of the spinous processes. In the neck they are represented by the ligamentum nuchæ.

The *posterior internal vertebral venous plexus* consists of two longitudinal plexuses one on either side of the middle line situated between the laminæ and ligamenta flava behind, and the dura mater covering the medulla spinalis in front. They communicate (1) with each other by transverse branches, (2) with the posterior external vertebral venous plexus outside the canal by branches passing through the ligamenta flava, (3) with the anterior internal vertebral venous plexus in front which now remains covered by the dura mater and (4) with the occipital sinus above. They send laterally branches which unite

with similar branches from the anterior internal vertebral venous plexus to form intervertebral veins.

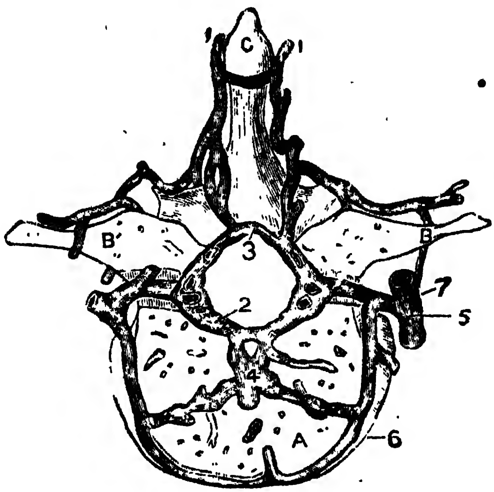


Fig. 58.—Diagram illustrating the vertebral venous plexuses (Gray).

A. Body of thoracic vertebra.
B. Transverse process.
C. Spinous process.
1. Posterior external venous plexus.
2. Anterior internal venous plexus.
3. Posterior internal venous plexus.
4. Venæ basis vertebræ.
5. Intercostal vein.
6. Anterior external venous plexus.
7. Intervertebral vein.

Spinal Arteries. -These supply the medulla spinalis and its membranes and the bones and ligaments bounding the vertebral canal. In well injected subjects they are readily seen. *In the cervical region* they are derived from (1) the vertebral artery, (2) the ascending cervical artery and (3) the arteria profunda cervicis. *In the thoracic region* they are derived from the posterior branches of the intercostal arteries. *In the lumbar region* they are derived

from the posterior branches of the lumbar arteries, and *in the sacral region* from the lateral sacral arteries. They enter the vertebral canal through the intervertebral or anterior sacral foramina and divide into three branches, of which one called the *lateral spinal artery* pierces the duramater with the spinal nerve to supply the medulla spinalis. Of the other two one passes in front of and the other behind the dura mater. These two anastomose with the branches of the arteries above and below thus forming anastomosing loops throughout the length of the canal. They also anastomose with the arteries of the opposite side by minute transverse twigs.

The **Membranes of the Medulla Spinalis** are three in number. From without inwards they are called the dura mater, the arachnoid and the pia mater.

The *dura mater* that is now exposed corresponds to the meningeal layer of the cranial dura mater. The endosteal layer of the cranial dura mater is continued down into the vertebral canal as the periosteum lining the bones which bound the canal. The venous plexuses on the surface of the dura mater spinalis correspond to the sinuses of the dura mater inside the cranium. Above, the spinal dura mater is attached to the margin of the foramen magnum. Below it extends as far as the lower margin of the second sacral vertebra. Here it is suddenly narrowed and prolonged as an adherent sheath of the filum terminale which is a thread-like structure continued from the termination of the medulla spinalis. As a sheath of the filum terminale it is prolonged over the back part of the coccyx where it blends with the periosteum covering it. Laterally it is prolonged as sheaths on the spinal nerves which pierce it. It presents two bulgings, one in the cervical region and the other in the lumbar region.

Open the dura mater along the middle line and note that its inner surface is smooth and glistening. It is

separated from the arachnoid by a capillary space called the *subdural cavity*. Note that laterally corresponding to each spinal nerve there are two openings in the dura mater, one for the anterior and the other for the posterior root. Note also that it does not send processes from its inner surface like the cranial dura mater.

The *arachnoid* is a very thin delicate membrane. It is continuous above with the arachnoid of the brain. Below it forms a loose sheath for the lumbar enlargement of the medulla spinalis and the bunch of nerves prolonged downwards forming the cauda equina. Laterally it is prolonged over the spinal nerve roots forming sheaths for them. The *subarachnoid cavity* is the interval between the arachnoid and the pia mater and contains cerebro-spinal fluid. It is continuous above with that in the cranium. Below the space is the largest where it encloses the nerves constituting the cauda equina and hence can be easily demonstrated. It is imperfectly subdivided into three compartments by three septa, one posterior and two lateral. The posterior one is called the *sub-arachnoid septum* (septum posticum) and connects the inner surface of the arachnoid with the pia mater posteriorly. The lateral septa are called the ligamenta denticulata and will be studied in detail later on.

Remove the arachnoid carefully from a part of the medulla spinalis and expose the pia mater beneath.

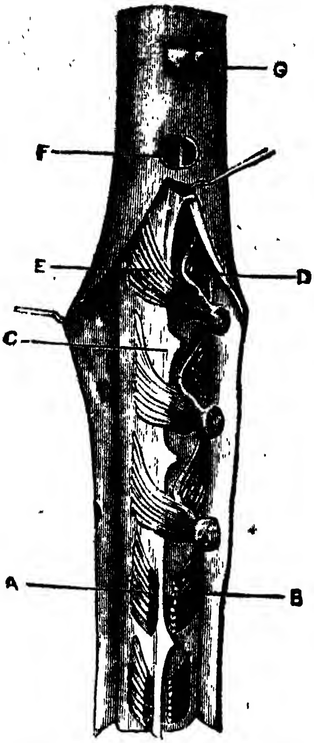
The *pia mater* is the nutritive membrane of the medulla spinalis as the vessels ramify in it abundantly to supply the substance of the spinal medulla. Above it is continuous with the pia mater covering the brain. Below where the medulla spinalis ends it gradually contracts and is continued downwards in the centre of the cauda equina as an investment of the filum terminale. It is firmly adherent to the medulla spinalis opposite the postero-median septum. Laterally it is thickened into

a longitudinal band called the ligamentum denticulatum and is prolonged on the spinal nerves as sheaths for them.

The **Medulla Spinalis** (Spinal cord) extends from the foramen magnum to the lower margin of the first lumbar vertebra where it ends in a tapering cone, called the *conus medullaris*. From the apex of the cone a narrow filament is continued downwards as far as the back part of the coccyx, called the filum terminale. The medulla spinalis is slightly flattened from before backwards. In the cervical and lower thoracic regions it presents enlargements. The *cervical enlargement* extends from the level of the third cervical vertebra to the first or second thoracic vertebra. The *lumbar enlargement* lies opposite the last three thoracic vertebræ.

The **Filum Terminale** is the slender filament prolonged from the tip of the conus medullaris and placed in the middle of the bunch of nerves called the cauda equina. It consists of pia mater enclosing a small amount of nervous elements. The central canal of the medulla spinalis is prolonged into its upper part. Opposite the lower border of the second sacral vertebra it pierces the tube of dura mater and receives an adherent sheath from it. Then it descends to be blended with the periosteum covering the back part of the coccyx. The upper portion of it within the tube of dura mater is called *filum terminale internum* and the lower portion with the adherent sheath of the dura mater is called the *filum terminale externum*.

Spinal Nerves.—There are thirty-one pairs of spinal nerves: eight pairs cervical, twelve pairs thoracic, five pairs lumbar, five pairs sacral, and one pair coccygeal. As a general rule each spinal nerve issues out of the vertebral canal through the intervertebral foramen and the sacral nerves come out through the sacral foramina. But there are exceptions: thus the first cervical nerve passes out between the occipital bone and the atlas; the second



cervical nerve passes out across the arch of the epistropheus ; and the fifth sacral nerve and the coccygeal nerve come out through the lower opening of the sacral canal. Each spinal nerve is formed by two roots, an anterior or motor root and a posterior or sensory root. A swelling, called the *spinal ganglion*, is seen on each of the posterior roots within the intervertebral foramen before its union with the anterior root. Cut away with bone forceps the contiguous articular processes of some of the thoracic vertebræ to see the ganglia on the posterior roots and the subsequent fusion of both the roots to form the nerve trunks. A minute nerve, called the *ramus meningeus*, will be seen entering the vertebral canal through the intervertebral foramen. It is formed by a filament from the spinal nerve-trunk uniting with a filament from the sym-

Fig. 59.—Lateral view of the medulla spinalis showing dura mater, ligamentum denticulatum and anterior and posterior nerve-roots (from Hirschfeld and Leveillé).

A, B. Fasciculi of origin of nerve-roots.
C. Ligamentum denticulatum.
D. Anterior nerve-root.
E. Posterior nerve-root.
F. Section through nerve-roots.
G. Spinal nerve with its sheath of dura mater.

pathetic trunk. It supplies the periosteum of the vertebral canal. The roots of the cervical and upper thoracic nerves are short and directed transversely lateralwards while the roots of the lower thoracic, lumbar, sacral and coccygeal nerves are very long and directed at first obliquely and then vertically downwards. As a rule the sutdent

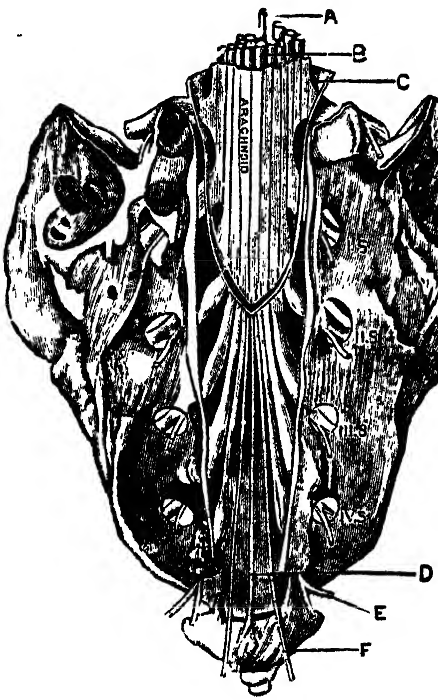


Fig. 60.—Sacral canal laid open from behind, showing the lower part of the cauda equina and the membranes lying in relation (from Testut).

A. Filum terminale.
B. Cauda equina.
C. Dura mater.
D. Filum terminale.
E. Fifth sacral nerve.
F. Coccygeal nerve.

will find the ganglion on the posterior root after its exit through the dura mater lying within the intervertebral foramen and the union of the anterior and posterior roots takes place within the same foramen. But there are certain exceptions to this; thus the ganglia on the posterior roots of the sacral nerves are developed within the sacral canal and the union of their anterior and posterior roots also takes place within the same canal. The ganglion on the posterior root of the coccygeal nerve is developed before it pierces the dura mater and its two roots blend within the sacral canal.

Removal of the Medulla Spinalis with its Membranes.—Divide the medulla spinalis with its membranes at the upper end of the vertebral canal exposed from behind. Divide the nerves keeping them as long as possible attached to the medulla spinalis. In the thoracic region some of the nerve roots have been traced through the intervertebral foramina to their fusion to form nerve trunks. Divide these nerve trunks. Lift the medulla spinalis with the attached nerves and remove it with the membranes in tact. Note that the dura mater is attached anteriorly to the posterior longitudinal ligament of the vertebræ by fibrous strands. Lastly detach the filum terminale from the back of the coccyx.

Place the medulla spinalis with its membranes on a thin light piece of wood with its anterior surface uppermost and fix it with pins. The piece of wood should be of the same length as the medulla spinalis and about two inches in breadth. Divide the dura mater with scissors along the median line; reflect the flaps on either side and fix their margins with pins on the piece of wood. The subdural cavity is opened up and the arachnoid is seen. Remove the arachnoid carefully. The pia mater on the anterior surface of the medulla spinalis is seen. It sends a process through the antero-median fissure of the medulla

spinalis and also presents a thickened band along this fissure called the *linea splendens.* An arterial trunk also descends along this line. Laterally the pia mater gives off a band which extends throughout the whole length of the medulla spinalis. This band, called the ***ligamentum denticulatum,*** is dentated or serrated on its lateral margin where it is attached by the pointed ends of the dentations (which are twenty-one in number) to the inner surface of the dura mater, by pushing the arachnoid in front of them. Medially it lies between the anterior and posterior roots of the spinal nerves in a continuous line from the foramen magnum to the level of the first lumbar vertebra.

The *anterior internal vertebral venous plexus* should now be examined in the anterior wall of the vertebral canal. It consists of two longitudinal venous trunks one on either side of the posterior longitudinal ligament of the vertebræ. They communicate (1) with each other opposite the body of each vertebra by a transverse branch which is covered by the posterior longitudinal ligament and into which the basivertebral vein opens. Above they communicate (2) with the basilar plexus or with the occipital sinus and behind (3) with the posterior internal vertebral plexus. Laterally they send off branches towards the intervertebral foramina which join with similar branches from the posterior venous plexus to form the *intervertebral veins.* These intervertebral veins open into the vertebral veins in the neck, into the intercostal veins in the thorax, into the lumbar veins in the lumbar region, and into the lateral sacral veins in the sacral region.

Arteries of the Medulla Spinalis.—There are five arterial channels running longitudinally along the medulla spinalis. One, the *antero-median spinal artery,* runs downwards longitudinally along the antero-median fissure beneath the linea splendens. It is formed near the fora-

men magnum by the meeting of the two anterior spinal branches of the vertebral artery. It is reinforced in the different regions by the lateral spinal arteries (p. 269). This trunk is prolonged for some distance into the filum terminale. The *postero-lateral spinal arteries* are four in number, two on each side, one lying in front of and the other behind the attachment of the posterior spinal nerve roots of the medulla spinalis. They begin in the right and left posterior spinal branches of the vertebral artery in the foramen magnum. Each divides into two branches one passing in front of and the other behind the posterior spinal nerve roots. These branches are reinforced in the different regions by the lateral spinal arteries. They terminate at the lower end of the medulla spinalis and are not prolonged over the filum terminale. Of the lateral spinal arteries in the different regions, some go to join the antero-median artery and the rest join the postero-lateral arteries.

Veins of the Medulla Spinalis.—These form plexuses on the surface of the medulla spinalis. Six longitudinal trunks can be recognised in the midst of these plexuses; one runs along the antero-median fissure beneath the arterial trunk. Another runs along the postero-median fissure. The other four run laterally, two on each side, one in front of and the other behind the posterior nerve roots. These trunks communicate freely with each other and send branches laterally along the nerve roots to join the internal vertebral venous plexuses.

The naked eye structure of the medulla spinalis now remains to be studied. For this purpose the medulla spinalis is to be hardened sufficiently before any sections can be made. Put the medulla spinalis in the same jar in which the brain has been preserved and the same lotions will harden it.

THE SIDE OF THE NECK.

On the eighth day after the subject has been placed in the dissecting-room, the dissection of the side of the neck is commenced. The subject is turned on its back and blocks are placed beneath the shoulders, chest and pelvis. The side of the neck is made tense by drawing the head backwards and turning the face to the opposite side. Replace the trapezius muscle in its position.

The area known as "the side of the neck" is quadrilateral in outline. It is *bounded*, in *front* by the middle line of the neck, *behind* by the anterior margin of the trapezius, *above* by the lower border of the mandible and a line drawn from the angle of the mandible along the mastoid process to the superior nuchal line of the occipital bone. The sterno-cleido-mastoid muscle crosses the space diagonally from above downwards and forwards and divides it into two triangles. The anterior triangle is placed in front of the muscle and the posterior triangle behind it.

Surface Anatomy.—Before the skin is reflected the following landmarks should be recognised. In the middle line of the neck from above downwards are :—(1) the symphysis menti, (2) the body of the hyoid bone, (3) the hyo-thyreoid membrane lying between the hyoid bone and the thyreoid cartilage, (4) the anterior border of the thyreoid cartilage with the laryngeal prominence (pomum Adami), (5) the crico-thyreoid membrane lying in the short gap between the thyreoid and cricoid cartilages, (6) the cricoid cartilage, (7) the isthmus of the thyreoid gland (sometimes felt crossing the third and fourth rings of

process to the sternal end of the clavicle and to the sternum.

Incisions.—(1) A vertical cut along the middle line of the neck from the chin to the superior border of the sternum; (2) a transverse incision from the lower end of the former incision along the clavicle to the acromion process of the scapula; (3) a diagonal incision along the anterior margin of the sterno-cleido-mastoideus from the mastoid process to the point of meeting of the first two incisions at the sternum (Fig. 3). Reflect the anterior triangular flap of skin from below upwards over the mandible and the posterior flap backwards.

The dissection of the side of the neck comprises an examination of:—

I. Structures superficial to the deep fascia of the neck, viz., (1) superficial fascia, (2) platysma, (3) external and anterior jugular veins, (4) superficial branches of the cervical plexus, (5) cervical branch of the facial nerve.

II. Fascia colli and the sterno-cleido-mastoideus.

III. The Anterior and Posterior Triangles of the neck.

Superficial Fascia.—In the male subject the superficial fascia is very thin and contains very little fat. The fibres of the platysma are seen through it.

The **Platysma** is a subcutaneous muscle lying over the anterior and posterior triangles of the neck. It arises below the clavicle from the superficial fascia over the deltoideus and the pectoralis major. The fibres of the muscle pass over the clavicle and proceed upwards and medialwards. The most anterior fibres interlace with the fibres of the opposite side below the symphysis menti. The posterior fibres are inserted into the mandible below the oblique line; some of the fibres pass upwards and intermingle with the muscles about the angle of the mouth and will be seen during the dissection of the face.

It is supplied by the cervical branch of the facial nerve which enters its deep surface.

Divide the platysma over the clavicle and reflect it upwards towards its insertion. Take care that the external and anterior jugular veins, the superficial branches of the cervical plexus and the cervical branch of the facial nerve which lie beneath the muscle are not injured.

The **External Jugular Vein** is formed by the union of the posterior auricular vein and the posterior division of the posterior facial vein in the substance of the parotid gland just behind the angle of the lower jaw. It runs down vertically along a line drawn from the angle of the lower jaw to the middle of the clavicle, crossing obliquely in its course the sterno-cleido-mastoideus. It pierces the deep fascia of the neck above the clavicle to open into the subclavian vein. Above, in the substance of the parotid gland it communicates by a branch with the internal jugular vein ; in the middle of its course it receives the posterior external jugular vein from the occipital region ; and lower down before opening into the subclavian vein it receives the transverse cervical, transverse scapular and anterior jugular veins. The external jugular vein lies closely related to some lymph glands, four to six in number, called the *superficial cervical lymph glands* whose efferent vessels dip at the anterior margin of the sterno-cleido-mastoideus to open into the superior deep cervical lymph glands.

The **Anterior Jugular Vein** is formed in the submaxillary region by the union of some small superficial veins. It runs down vertically close to the middle line of the neck. Above the medial end of the clavicle the vein pierces the deep fascia, proceeds lateralwards beneath the sterno-cleido-mastoideus and opens either into the external jugular or into the subclavian vein. Above the sternum and between the two layers of the fascia colli

there, a communication takes place between the anterior jugular veins of the two sides by a transverse branch. The anterior jugular vein may be absent on one side. Its size varies inversely with that of the external jugular vein.

Superficial Branches of the Cervical Plexus.—These perforate the fascia colli at the posterior border of the sterno-cleido-mastoideus at about its middle and may be grouped into ascending, transverse and descending branches as follows :—

Ascending	The small occipital nerve. The great auricular nerve.
Transverse	The nervus cutaneus colli.
Descending	The supraclavicular nerves.

The **Small Occipital Nerve** is derived from the anterior divisions of the second cervical nerve. It runs up along the posterior border of the sterno-cleido-mastoideus to the scalp where its distribution has been examined (p. 226).

The **Great Auricular Nerve** is derived from the anterior divisions of the second and third cervical nerves. It crosses the sterno-cleido-mastoideus obliquely and runs upwards towards the ear. It divides into two branches, an anterior and a posterior. The distribution of the posterior branch over the mastoid process and the auricula has been examined (p. 226). The anterior branch supplies the skin over the parotid gland and will be traced during the dissection of the face.

The **Nervus Cutaneus Colli** (Transverse cervical nerve) is derived from the anterior divisions of the second and third cervical nerves. It passes forwards to the anterior triangle of the neck crossing the sterno-cleido-mastoideus horizontally. In the anterior triangle it divides into ascending and descending branches. The *ascending branches* communicate with the cervical branch

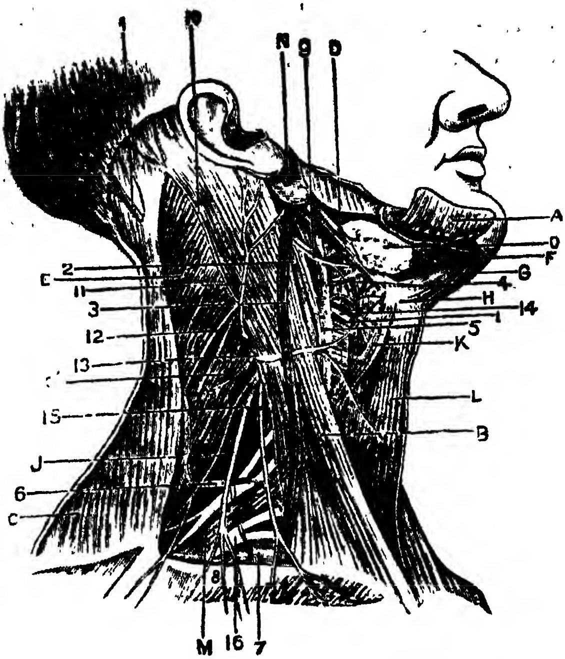


Fig. 61.—Superficial dissection of the triangles of the neck (drawn by J. T. Gray).

A. Platysma (turned up).
B. Sterno-cleido-mastoideus.
C. Trapezius.
D. Posterior belly of digastricus and stylo-hyoideus.
E. Splenius capitis.
F. Mylohyoideus.
G. Anterior belly of digastricus.
H. Hyoid bone.
I. Inferior constrictor of pharynx.
J. Scaleni medius and posterior.
K. Superior belly of omo-hyoideus.
L. Sterno-hyoideus.
M. Inferior belly of omo-hyoideus.
N. Parotid gland.

1. Occipital artery.
2. Internal jugular vein.
3. External jugular vein.
4. External carotid artery.
5. Common carotid artery with descendens hypoglossi nerve.
6. Transverse cervical artery.
7. Subclavian artery.
8. Transverse scapular artery.
9. Hypoglossal nerve.
10. Smaller occipital nerve.
11. Great auricular nerve.
12. Accessory nerve.
13. Nervus cutaneus colli.
14. Superior laryngeal nerve.
15. Descending branches (superficial) of the cervical plexus.
16. Brachial plexus.

of the facial nerve and perforating the platysma, supply the skin of the submaxillary region. The *descending branches* pass downwards, pierce the platysma and supply the skin at the lower and front part of the neck.

The **Supraclavicular Nerves** originate from a single trunk derived from the anterior divisions of the third and fourth cervical nerves. This trunk appears beneath the posterior border of the sterno-cleido-mastoideus at about its middle and soon divides into three branches, viz., anterior, middle and posterior supraclavicular nerves. The *anterior supraclavicular nerves* (suprasternal branches) run downwards and medialwards, pierce the deep fascia above the clavicle and cross its sternal end to supply the skin over the sternum. The *middle supraclavicular nerves* (supraclavicular branches) cross the clavicle at its middle to supply the skin over the pectoralis major and deltoideus. The *posterior supraclavicular nerves* (supraacromial branches) descend over the trapezius and the acromion process to supply the skin over the upper and back parts of the shoulder.

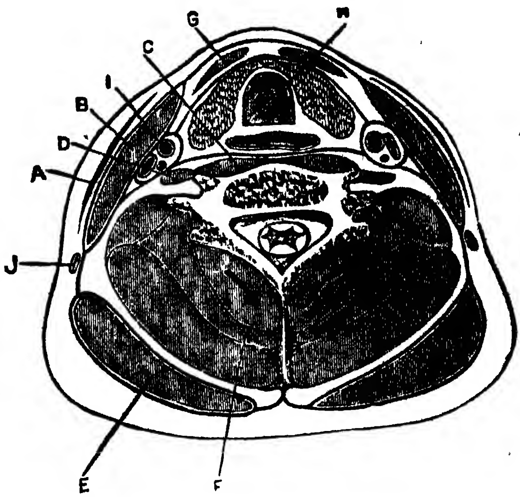
The **Cervical Branch of the Facial Nerve** pierce the fascia colli near the angle of the mandible and proceeds forwards beneath the platysma, communicating with the ascending branches of the nervus cutaneus colli. It enters the deep surface of the platysma to supply it.

The **Fascia Colli** (Deep cervical fascia) constitutes a complete investment for all the structures of the neck and sends off processes from its deep surface subdividing the enclosed space into compartments. At this stage of dissection the student observes the fascia as it roofs in both the anterior and posterior triangles of the neck. As the dissection proceeds he should study the processes that are given off from its deep surface. During the dissection of the back of the neck the deep fascia was seen to cover both surfaces of the trapezius muscle. At the

anterior border of the muscle these two layers reunite to form a single layer which passes forwards covering the posterior triangle. At the posterior margin of the sterno-cleido-mastoideus this layer splits to enclose the muscle. At the anterior margin of the muscle the two layers reunite at the upper part to form a single layer which is continued to the middle line of the neck to be continuous with the fascia of the opposite side. At the anterior margin of the lower part of the sterno-cleido-mastoideus, close to the sternum, these two layers do not unite but pass as separate layers to the middle line to be continuous with the similar two layers of the opposite side. Thus an interval is left between these two layers—a superficial and a deep - at the upper border of the manubrium sterni, called the *supra-sternal space* (space of Burns). The superficial layer is attached to the anterior border and the deep layer to the posterior border of the upper end of the sternum. Incise the superficial layer and note that the supra-sternal space contains (1) the lower ends of the anterior jugular veins and the transverse branch of communication between them; (2) the sternal origins of the sterno-cleido-mastoideus; (3) a little areolar tissue containing fat and (4) sometimes a lymph gland. *In the middle line* the fascia colli is attached to the body of the hyoid bone and to the symphysis menti. *Above* it is atatched to the lower border of the mandible as far back as its angle. Behind the angle it splits to enclose the parotid gland; the superficial layer covering it superficially and the deep layer passing under the gland. The former is called the parotideo-masseteric fascia and will be seen during the dissection of the face to be attached to the zygomatic arch. The deep layer will be studied later on. Further back the fascia colli is attached above to the mastoid process and superior nuchal line of the occipital bone. *Below* the fascia is attached to the manu-

brium sterni, to the clavicle and the acromion process of the scapula. Between the two scapulæ it is prolonged downwards to be continuous with the thoracic portion of the lumbodorsal fascia.

The processes given off from the fascia colli lining the deep surface of the sterno-cleido-mastoideus are :—(1) the prevertebral fascia from which another thin lamina called the buccopharyngeal fascia is given off, (2) the pretracheal fascia, (3) the carotid sheath and (4) the fascia of the omohyoideus. Besides these processes some thickened bands will be noticed in connection with them. All



No. 62.—Transverse section through the lower part of the neck, to show the arrangements of the deep cervical fascia (diagrammatic)—from Treves.

A. Platysma.
B. Sterno-cleido-mastoideus.
C. Prevertebral muscles.
D. Scalenus anterior.
E. Trapezius.
F. Deep muscles on back of neck.
G. Depressor muscles of larynx and hyoid bone.
H. Trachea.
I. Carotid artery and its sheath.
J. External jugular vein.

these processes and thickened bands will be examined later on.

The dissector should now clean the sterno-cliedo-mastoideus by removing from its surface the thin layer of the fascia colli and should define its origin and insertion.

The **Sterno-cleido-mastoideus** arises by two heads, one from the sternum and the other from the clavicle. The *sternal head* arises from the upper part of the anterior surface of the manubrium sterni by a thick rounded tendon. The *clavicular head* arises from the superior border aud anterior surface of the sternal end of the clavicle by fleshy and aponeurotic fibres. The two heads remain separated from each other by an oblique cleft below, but at about half way up the neck they unite into a thick muscle which ascends to be inserted into the outer surface of the mastoid process and into the lateral half of the superior curved line of the occipital bone. It is supplied by the accessory nerve which pierces it and by the second cervical nerve.

The dissection of the posterior triangle of the neck should now engage the attention of the student. The head is to be turned to the opposite side and fixed by hooks and the shoulder is to be depressed. As this position interferes with the dissection of the axilla, the dissector of the head and neck should stop work when the dissector of the axilla works and vice versa. The layer of fascia colli which stretches between the anterior margin of the trapezius and the posterior margin of the sterno-cleido-mastoideus is to be removed. The inferior belly of the omohyoideus, the transverse cervical and transverse scapular vessels and some lymph glands lie embedded in the fatty tissue in the supraclavicular region. Clean these structures and note that a process from the fascia colli lying behind the sterno-cleido-mastoideus descends to enclose the tendon of the omohyoideus and becomes attached to the posterior border of the clavicle.

The nerve twig lying under cover of the sterno-cleido-mastoideus and entering the inferior belly of the omo-hyoideus is to be secured. Another process of the fascia colli originating from the layer which lies behind the sterno-cleido-mastoideus will be seen passing downwards covering the subclavian vessels and the brachial plexus of nerves. This is continuous with the prevertebral fascia in the anterior triangle of the neck. This layer is to be removed and the blood vessels and nerves covered by it cleaned. And lastly the slender nerve supplying the subclavius muscle which descends vertically from the trunk formed by the fifth and sixth cervical nerves is to be secured.

The **Posterior Triangle** is *bounded* in front by the posterior margin of the sterno-cleido-mastoideus, behind by the anterior margin of the trapezius, its base is formed by the middle third of the clavicle, and its apex corresponds to the meeting of the sterno-cleido-mastoideus and the trapezius or the superior nuchal line of the occipital bone when these two muscles do not meet. It is subdivided by the inferior belly of the omohyoideus into two unequal triangles—an upper, larger triangle, called the occipital triangle; and a lower, smaller triangle, called the subclavian triangle.

The **Occipital Triangle** is *bounded* in front by the posterior margin of the sterno-cleido-mastoideus; behind by the anterior margin of the trapezius; and below by the inferior belly of the omohyoideus. Its *floor* is formed from above downwards by the splenius capitis, the levator scapulæ the scaleni medius and posterior.

The *contents* of the triangle are :—

I. Vessels

1. The occipital artery (when the sterno-cleido-mastoideus and the trapezius do not meet at the occiput).
2. Transverse cervical artery and vein.

II. Nerves
1. The accessory nerve.
2. The upper part of the brachial plexus.
3. The superficial branches of the cervical plexus.
4. Branches from the third and fourth cervical nerves which supply the trapezius.
5. Branches from the third and fourth cervical nerves which supply the levator scapulæ.

III. Lymph glands lying along the posterior margin of the sterno-cleido-mastoideus.

The **Subclavian Triangle** is *bounded* in front by the posterior margin of the sterno-cleido-mastoideus; below by the middle third of the clavicle; and above by the inferior belly of the omohyoideus. It varies very much in size; thus the size of the space is much reduced (1) in muscular subjects owing to the attachments of the sterno-cleido-mastoideus and the trapezius to the clavicle approaching each other; (2) if the inferior belly of the omohyoideus runs close to the clavicle. The *floor* is formed by the scaleni medius and posterior, a portion of the first rib and the first digitation of the serratus anterior.

The *contents* of the subclavian triangle should now be studied. These are:—

(1) The third part of the subclavian artery and the subclavian vein.

(2) Transverse scapular artery and vein.

(3) Transverse cervical artery and vein.

(4) Terminal part of the external jugular vein.

(5) The trunks of the brachial plexus with their branches given off above the clavicle.

(6) Lymph glands, lying along the posterior margin of the sterno-cleido-mastoideus.

Subclavian Artery.—The third portion of the subclavian artery is seen in the subclavian triangle. This portion extends from the lateral margin of the scalenus anterior to the outer border of the first rib where it becomes the axillary artery. No branch is usually given off from this portion of the artery. This portion of the artery is most superficial and consequently the artery is ligatured here when the surgeon has a choice. The relations of this part of the vessel are therefore a matter of great importance and may be tabulated as follows :—

(I) Relations to fasciæ, muscles and bones :—

The superficial fascia, the platysma, the deep cervical fascia, the clavicle and the subclavius muscle lie *in front* of it. It lies against the first rib and the scalenus medius muscle.

(II) Relations to arteries, veins and nerves :—

Arteries	Transverse cervical Transverse scapular	cross from medial to lateral side.
Veins	Transverse cervical Transverse scapular	cross from lateral to medial side.
	External jugular ..	crosses from above downwards.
	Subclavian ..	lies below and in front.
Nerves	Trunks of brachial plexus	upper two trunks lie above; lower trunk behind.
	Nerve to subclavius	crosses from above downwards.
	Supraclavicular nerves	cross from above downwards.

The **Transverse Cervical Artery** is one of the branches of the thyreocervical trunk. It issues from beneath the sterno-cleido-mastoideus and passes lateralwards along

the apex of the subclavian triangle crossing the brachial plexus of nerves. Reaching the trapezius it passes beneath its anterior margin where its division into ascending and descending branches has been noted (p. 251). Its *companion vein* opens into the external jugular vein.

The **Transverse Scapular Artery** (Suprascapular artery) arises from the thyreocervical trunk. It passes lateralwards in front of the third portion of the subclavian artery and the cords of the brachial plexus and under cover of the clavicle. Then it passes beneath the trapezius towards the upper border of the scapula. It will be traced again during the dissection of the superior extremity. The *companion vein* opens into the external jugular vein.

External Jugular Vein.—Its terminal part should now be examined. It opens into the subclavian vein and is provided with a pair of valves at its entrance. Near its termination it receives the anterior jugular vein medially and the transverse cervical and transverse scapular veins laterally.

Brachial Plexus.—Its upper part lies in the neck and its lower part in the axilla. This plexus should therefore be studied in conjunction with the dissector of the superior extremity. If the dissection of the axilla has been completed, the middle third of the clavicle is to be removed with a saw detaching the subclavius muscle from its under surface. Divide this muscle at its attachment laterally to the portion of the clavicle still intact and reflect it medially together with its nerve.

The brachial plexus is formed by the anterior divisions of the fifth, sixth, seventh and eighth cervical nerves and the greater part of the anterior division of the first thoracic nerve. Usually a branch from the fourth cervical nerve joins the fifth cervical and not infrequently a branch from the second thoracic communicates with the first thoracic nerve. These nerves constitute the *roots*

of the plexus and lie between the scaleni anterior and medius. Three *trunks* are then formed by the union of these roots thus: the fifth and sixth cervical nerves unite to form a trunk, called the *upper trunk* ; the seventh cervical remains alone forming the *middle trunk* ; while the eighth cervical and the branch from the first thoracic unite to form the *lower trunk*. The upper and middle trunks lie above the subclavian artery whilst the lower trunk lies behind it. Each of the three trunks formed in this way divides a little above the clavicle into an *anterior* and a *posterior division*. These divisions lie on the lateral side of the first part of the axillary artery. The anterior divisions of the upper and middle trunks unite to form the *lateral cord*. The anterior division of the lower trunk remains alone forming the *medial cord* whilst the posterior divisions of all the three trunks unite to form the *posterior cord*. The lateral, medial and posterior cords occupy the corresponding sides of the second part of the axillary artery. The following table shows at a glance the formation of the brachial plexus :—

Roots.	5th and 6th C.Ns. = Upper trunk = ant. dvn.	Lateral cord.	and Post. dvn.	Posterior cord.
	7th C.N. = Middle Trunk = ant. dvn.		and Post. dvn.	
	8th C.N. and 1st Th.N. = Lower trunk = ant. dvn.	Medial cord	and Post. dvn.	

The **Branches of the Brachial Plexus** can be divided into two sets, viz., those which arise *above* the clavicle and those *below* that bone. The branches given off above the clavicle are called the supraclavicular branches and belong to the dissector of the head and neck. The supraclavicular branches are :—(1) The *communicating branch to the phrenic nerve*. It is derived from the fifth cervical

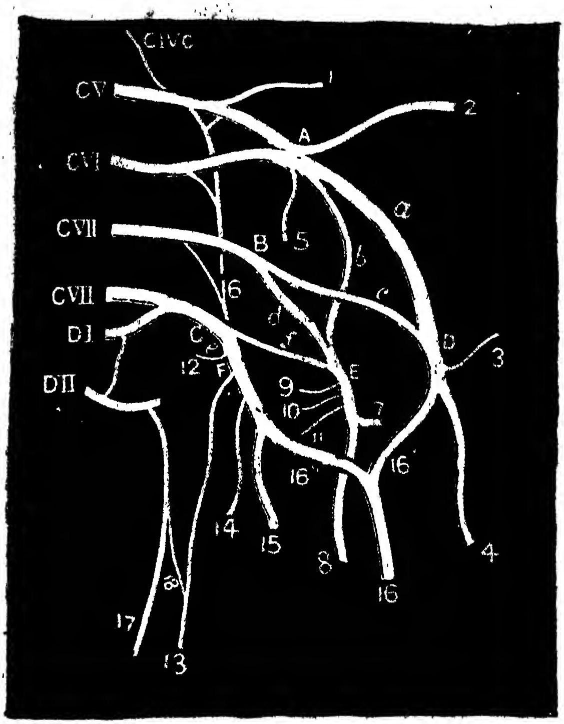


Fig. 63.—Diagram of the brachial plexus of nerves (Cunningham).

CIVC. Communicating branch from the fourth cervical nerve.

CV, CVI, CVII, CVIII, DI, DII. Anterior primary divisions of the fifth, sixth, seventh, eighth, first and second thoracic nerves.

A. Upper trunk dividing into *a*, *b*, anterior and posterior divisions.

B. Middle trunk dividing into *c*, *d*, anterior and posterior divisions.

C. Lower trunk dividing into *e*, *f*, anterior and posterior divisions.

D. Lateral cord.

E. Posterior cord.

F. Medial cord.

1. Dorsal scapular nerve.
2. Suprascapular nerve.
3. Lateral anterior thoracic nerve.
4. Musculo-cutaneous nerve.
5. Nerve to subclavius.
6. Long thoracic nerve.
7. Axillary nerve.

8. Radial nerve.
9, 11. Upper and lower subscapular nerves.
10. Thoracodorsal nerve.
12. Medial anterior thoracic nerve.
13. Medial brachial cutaneous nerve.
14. Medial antibrachial cutaneous nerve.
15. Ulnar nerve.
16. Median nerve.
16'. Lateral head of median nerve.
16". Medial head of median nerve.
17. Intercosto-brachial nerve.
18. Communicating twig from the intercosto-brachial nerve to the medial brachial cutaneous nerve.

nerve and joins the phrenic nerve on the scalenus anterior muscle. (2) *Muscular branches* to the scaleni and longus colli which are derived from the lower four cervical nerves soon after their exit from the intervertebral foramina. (3) The *dorsal scapular nerve* (nerve to Rhomboidei) arises from the fifth cervical nerve, pierces the scalenus medius and passes beneath the levator scapulæ to the back in company with the descending branch of the transverse cervical artery. It will be traced again during the dissection of the superior extremity. This nerve occasionally supplies a twig to the levator scapulæ. (4) The *nerve to the subclavius* is a slender twig which arises from the upper trunk of the plexus and descends in front of the third part of the subclavian artery to supply the subclavius. (5) The *suprascapular nerve* arises from the upper trunk of the brachial plexus, passes downwards and lateralwards beneath the inferior belly of the omohyoideus and the anterior margin of the trapezius and enters the supraspinous fossa by passing through the suprascapular notch. (6) The *long thoracic nerve* (Posterior thoracic or external respiratory nerve of Bell) arises by three roots from the fifth, sixth and seventh cervical nerves. The roots from the fifth and sixth cervical nerves pierce the scalenus medius and that from the seventh cervical nerve passes in front of the muscle. The nerve descends behind the brachial plexus and the axillary vessels and lies against the outer surface of the serratus anterior supplying twigs to each of its digitations.

The *inferior deep cervical lymph glands* are seen in the subclavian triangle closely related to the subclavian vein and the trunks of the brachial plexus. They receive efferents from the superior deep cervical lymph glands and their efferents form a lymph trunk, the *jugular trunk*, which opens into the junction of the internal jugular vein and the subclavian vein on the right side and on the left side it opens into the thoracic duct.

The **Accessory Nerve** (Spinal accessory nerve) appears at the upper part of the occipital triangle by piercing the sterno-cleido-mastoideus. It then crosses the triangle obliquely downwards, lateralwards and backwards and enters the deep surface of the trapezius.

Branches from the third and fourth cervical nerves to the trapezius.—These two branches also cross the posterior triangle below the accessory nerve obliquely downwards, lateralwards and backwards and enter the deep surface of the trapezius. They communicate with the accessory nerve. *Branches from the third and fourth cervical nerves to the levator scapulæ.*—These are minute twigs entering the levator scapulæ near its origin.

In the occipital triangle, some *lymph glands* are found at the posterior margin of the sterno-cleido-mastoideus. Their efferents pass to the inferior deep cervical lymph glands.

The dissector of the superior extremity removes the limb from the trunk at this stage. He divides the blood vessels and nerves at the outer border of the first rib.

THE FACE.

The dissector of the head and neck should now proceed to dissect the face as this part tends to dry up soon. The dissection of the anterior triangle will be taken up later on.

Before commencing the dissection of the face the student should examine the various parts of the external ear and the appendages of the eye.

External Ear.—The ear (organ of hearing) is divisible into three portions: the external ear, the middle ear and the internal ear. The external ear consists of (1) a fibrocartilaginous expanded portion covered with skin, called the pinna or auricula and (2) the external acoustic meatus.

Auricula or Pinna.—Different names have been given to the various parts of the pinna. The folded margin of the pinna is called the *helix*. In front of the helix and separated from it by a curved depression, called the *scapha* (fossa of the helix), is another curved prominence called the *antihelix*. The antihelix bifurcates at its upper extremity, presenting a triangular depression between the two diverging limbs called the *fossa triangularis* (fossa of the antihelix). The broad deep cavity bounded posteriorly by the antihelix is called the *concha*. The concha is partially subdivided by the *crus* or anterior end of the helix into an upper part called the *cymba conchæ* and a lower part called the *cavum conchæ*. The conical projection in front of the concha and projecting backwards over the external acoustic meatus is called the *tragus*. Behind the tragus and separated from it by a notch (*intertragic notch*) is another nodule called the *antitragus*. The lowest soft dependent part of the ear is called the *lobule*.

The *external acoustic meatus* is a canal consisting of a medial bony portion and a lateral cartilaginous portion. The latter is a *tubular* prolongation from the pinna itself fixed to the lateral margin of the bony external acoustic meatus.

Remove the skin carefully from the auricula. The

cartilage, the ligaments and the intrinsic muscles of the auricula are now exposed.

The cartilage of the auricula extends over the whole auricula but is absent from the lobule. The helix at the posterior margin of the auricula is prolonged downwards as a tail like process called the *cauda helicis*. Between this and the antihelix is a fissure called the *fissura antitragohelicina*. A small eminence, called the *spina helicis*, is seen where the helix bends upwards in front. Between the tragus and the helix is a gap in the cartilage which is filled up by dense fibrous tissue. The auricular cartilage is prolonged from the bottom of the concha as a tubular process which is fixed to the margin of the porus acusticus externus of the temporal bone. This forms the cartilaginous portion of the external acoustic meatus. The cartilaginous tube is incomplete being deficient above and anteriorly, the gap being filled up by dense fibrous tissue.

The *ligaments of the auricula* are three in number. The *anterior* passes from the spina helicis to the root of the zygomatic process of the temporal bone. The *superior* extends from the concha to the temporal fascia. The *posterior* extends from the concha to the outer surface of the mastoid process.

The *intrinsic muscles* of the ear are:—(1) the *helicis major* which arises from the spina helicis and is inserted into the anterior margin of the helix. (2) The *helicis minor* covers the lateral surface of the crus helicis. (3) The *tragicus* consists of vertical fibres on the lateral surface of the tragus. (4) The *antitragicus* arises from the lateral surface of the antitragus and is inserted into the antihelix and cauda helicis. (5) The *transversus auriculæ* lies on the cranial surface of the auricula and extends from the prominence of the concha to the prominence of the helix. (6) The *obliquus auriculæ*, also on

the cranial surface, extends from the prominence of the concha to the eminentia triangularis, opposite the the fossa triangularis.

Appendages of the Eye.—These consist of the eyebrows, the eyelids, the conjunctiva and the lacrimal apparatus.

The *eyebrows* are two curved eminences of the skin placed over the upper margin of the orbit and covered with short stiff hairs. The *eyelids* are two crescentic folds which cover and protect each eyeball. The upper lid is larger and more movable than the lower one. When the eye is open an elliptical interval between the eyelids is seen called the *palpebral fissure.* When the eyelids are closed the fissure is reduced to a transverse slit. The two eyelids meet at the extremities of the palpebral fissure and form the medial and lateral *palpebral commissures* or *canthi.* At the medial canthus the two eyelids are separated from each other by a triangular interval called the *lacus lacrimalis.* To the free margin of each eyelid lateral to the lacus lacrimalis are attached the eyelashes. Behind the attachment of the eyelashes are seen the minute openings of the *ciliary glands* (Meibomian follicles). The margins of the eyelids where they bound the lacus lacrimalis are devoid of eyelashes and ciliary glands and present at their lateral ends an elevation called the *papilla lacrimalis,* at the summit of which a minute opening is seen called the *punctum lacrimalis.*

The *conjunctiva* is the mucous membrane lining the inner surface of the eyelids and the front of the eyeball; the part which lines the eyelids is called the *palpebral conjunctiva,* while that lining the eyeball, the *ocular conjunctiva.* The line along which the conjunctiva lining the eyelids is reflected on to the eyeball is called the *fornix conjunctivæ*; that from the upper eyelid on to the eyeball is called the *superior fornix* and that from the lower eyelid, the *inferior fornix.* At the centre of the lacus

lacrimalis there is a small reddish conical elevation, called the *caruncula lacrimalis* with a few tiny hairs attached to it. On the lateral side of the caruncula lacrimalis is seen a vertical fold of the conjunctiva called the *plica semilunaris.* It is the representative of the membrana nictitans or the third eyelid found in birds and many other animals.

The different strata of the eyelids and the lacrimal apparatus will be studied at a later stage of dissection.

Put a little cotton wool beneath the eyelids so as to make them tense and then stitch their free margins together. Similarly insert a plug of tow into the mouth to make the cheeks and lips tense and then stitch the margins of the lips together. Make a vertical incision just in front of the ear. The extremities of this incision are to meet the horizontal incisions above and below. Reflect the skin towards the middle line. In doing this great care is to be taken, for the subcutaneous tissue between the skin and the pale facial muscles is very scanty in many places and is altogether absent over the eyelids. Take care of the platysma as it passes upwards from the neck to blend with the facial muscles at the angle of the mouth. Clean the fascia over the parotid gland and the masseter muscle. Look for the anterior branch (facial branch) of the great auricular nerve which supplies the skin over the parotid gland.

The *anterior branch of the great auricular nerve* (facial branch) supplies the skin over the parotid gland and sends twigs through the gland to communicate with the facial nerve.

The parotideo-masseteric fascia is the deep fascia of the face. It covers the parotid gland behind and the masseter muscle in front. It is continuous below with the deep fascia of the neck and above it is attached to the zygomatic arch.

The muscles of the face may be divided into three groups :—(I) Those of the eyelids ; (II) those of the mouth ; and (III) those of the nose.

Muscles of the eyelids	1. The orbicularis oculi.
	2. The levater palpebræ.
	3. The corrugator.

The **Orbicularis Oculi** is the sphincter muscle of the eyelids. It consists of three portions, orbital, palpebral and lacrimal. The *orbital portion* is placed around the margin of the orbit ; its fibres extending lateralwards over the temple, upwards over the forehead and downwards over the cheek. It consists of elliptical loops which arise (1) from the medial palpebral ligament, (2) from the frontal process of the maxilla, and (3) from the nasal part of the frontal bone. The loops completely encircle the eyelids around the lateral canthus. The *palpebral portion* is placed upon and limited to the eyelids. It arises from the medial palpebral ligament and extends lateralwards upon both the eyelids in the form of concentric curves to be inserted into the lateral palpebral raphe. Close to the free margins of the eyelids the loops are thickened to form what is called the *ciliary bundle*. The *lacrimal portion* (tensor tarsi) will be studied during the dissection of the orbit. The muscle is supplied by the facial nerve.

The *levator palpebræ* will be studied during the dissection of the orbit.

The **Corrugator** (corrugator supercilii) is a small muscle which remains covered by the medial part of the orbicularis oculi and the frontalis. It arises from the medial end of the superciliary arch and passes upwards and lateralwards through the fibres of the orbicularis oculi and frontalis to be inserted into the skin of the forehead opposite the middle of the eyebrow. It is supplied by the facial nerve.

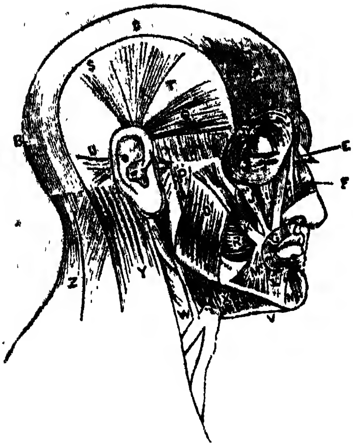


Fig. 64.—Muscles of the face (Wilson).

A. Frontalis muscle.
B. Occipitalis muscle.
C. Galea aponeurotica.
D. Orbicularis oculi.
E. Procerus.
F. Nasalis.
G. Orbicularis oris.
H. Quadratus labii superioris (angular head).
I. Its infraorbital head.
J. Its zygomatic head.
K. Zygomaticus.
L. Quadratus labii inferioris.
M. Triangularis.
N. Mentalis.
O. Masseter (superficial portion).
P. Masseter (deep portion).
Q. Auricularis anterior.
R. Buccinator.
S. Auricularis superior.
T. Temporal fascia.
U. Auricularis posterior.
V. Digastric (anterior belly).
W. Stylohyoid pierced by the posterior belly of the digastric.
X. Mylohyoid.
Y. Sterno-cleido-mastoideus.
Z. Trapezius.

The muscles of the mouth may be divided into three groups as follows :—

Superior group	1. Quadratus labii superioris. 2. Caninus. 3. Zygomaticus.
Inferior group	1. Mentalis. 2. Quadratus labii inferioris. 3. Triangularis.
Intermediate group	1. Orbicularis oris. 2. Risorius. 3. Buccinator.

The Quadratus Labii Superioris has a broad origin divisible into three heads. The medial or *angular head*

(Levator labii superioris alæque nasi) arises from the upper portion of the frontal process of the maxilla passes downwards and divides into a nasal and a labial slip. The nasal slip is inserted into the alar cartilage and skin of the nose. The labial slip is blended with the orbicularis oris. The intermediate or *infraorbital head* (levator labii superioris) arises from the lower margin of the orbit just above the infraorbital foramen and is inserted into the orbicularis oris and the skin of the upper lip. The lateral or *zygomatic head* (zygomaticus minor) arises from the facial surface of the zygomatic bone behind the zygomatico-maxillary suture and passes downwards and medialwards to be inserted into the orbicularis oris and the skin of the upper lip.

The **Caninus** (Levator anguli oris) arises from the canine fossa below the infraorbital foramen under cover of the infraorbital head of the quadratus labii superioris. It passes downwards and lateralwards to become inserted into the angle of the mouth where its fibres blend with those of the orbicularis oris.

The **Zygomaticus** (Zygomaticus major) arises from the zygomatic bone in front of the zygomatico-temporal suture. It passes downwards and medialwards to become inserted into the angle of the mouth where its fibres blend with those of the caninus, orbicularis and triangularis.

The **Mentalis** (Levator labii inferioris or levator menti) arises from the incisive fossa of the mandible and passes downwards to be inserted into the skin of the chin.

The **Quadratus Labii Inferioris** (Depressor labii inferioris) arises from the oblique line of the mandible between the symphysis menti and the mental foramen. The fibres pass upwards and medialwards, blend with those of the orbicularis oris and are inserted into the skin of the lower lip.

The **Triangularis** (Depressor anguli oris) arises by its broad base from the oblique line of the mandible below and lateral to the origin of the quadratus labii inferioris. It is inserted by its apex into the angle of the mouth, where its fibres blend with those of the orbicularis oris and the risorius.

The **Orbicularis Oris** surrounds the oral aperture and serves as its sphincter muscle. Its fibres are derived partly from the continuation into the lips of the fibres of the buccinator, the caninus and the triangularis. The fibres from the caninus pass along the angle of the mouth to the lower lip and those of the triangularis into the upper lip. The fibres of the buccinator pass into both the lips. Some fibres are also derived from the other facial muscles passing into the lips. Besides these fibres there are additional bands in the upper and lower lips. Thus on each side of the middle line in the upper lip there are two bands, (1) the medial band or the *musculus nasolabialis* attached above to the back part of the nasal septum, (2) the lateral band or the *musculus incisivus labii superioris* attached to the alveolar border of the maxilla corresponding to the lateral incisor tooth. On each side of the middle line in the lower lip there is a band called the *musculus incisivus labii inferioris* which is attached below to the alveolar border of the mandible corresponding to the lateral incisor tooth.

The **Risorius** arises from the parotideo-masseteric fascia and is inserted into the skin at the angle of the mouth mingling with the fibres of the orbicularis oris.

Next clean the buccinator muscle. The surface of the muscle is covered by a layer of fascia, the bucco-pharyngeal fascia, on which there is a pad of fat (*suctorial pad*) posteriorly. One or two lymph glands, called the *buccal lymph glands*, may be seen on the surface of the

muscle. The parotid duct will be seen piercing the muscle.

The **Buccinator** arises from the outer surfaces of the alveolar processes of the maxilla and the mandible as far forwards as the first molar tooth. Behind it arises from the pterygomandibular raphe which extends from the hamulus of the medial pterygoid lamina to the back part of the mylohyoid line. This raphe separates it from the superior constrictor of the pharynx and will be examined later on. At the angle of the mouth the upper fibres pass into the upper lip and the lower fibres into the lower lip but the intermediate fibres decussate so that the upper fibres pass into the lower lip and the lower fibres into the upper lip.

Muscles of the Nose:
1. Procerus.
2. Nasalis.
3. Depressor septi.
4. Dilatator naris posterior.
5. Dilatator naris anterior.

The **Procerus** (Pyramidalis nasi) arises by its broad base from the fascia covering the lower part of the nasal bones and the adjoining part of the lateral nasal cartilage. It is inserted by its narrow end into the skin over the glabella ; some of its fibres intermingling with those of the frontalis.

The **Nasalis** (Compressor naris) consists of two parts, transverse and alar. The *transverse part* arises from the maxilla above and lateral to the incisive fossa and passes upwards and medialwards across the cartilaginous part of the lateral wall of the nose to end in an aponeurosis. This aponeurosis is continuous with that of the opposite side over the bridge of the nose and from it the procerus takes its origin. The *alar part* arises from the greater alar cartilage of the nose and is inserted into the skin at the tip of the nose.

The **Depressor Septi** arises from the incisive fossa of the maxilla and passes upwards and forwards to be inserted into the lower and back part of the septum and ala of the nose.

The **Dilatator Naris Posterior** arises from the lateral margin of the nasal notch of the maxilla and is inserted into the skin at the margin of the nostril.

The **Dilatator Naris Anterior** is a thin fasciculus situated in front of the preceding muscle. It arises from the greater alar cartilage and is inserted into the skin at the margin of the nostril.

Nerve-supply.—All the facial muscles are supplied by branches of the facial nerve.

The dissector should now study the parotid gland and its duct.

The **Parotid Gland** is the largest of the salivary glands. It is placed on the side of the face below and in front of the external ear. It is limited above by the zygomatic arch; below by a line drawn from the angle of the mandible to the tip of the mastoid process; behind by the anterior border of the mastoid process and the sterno-cleido-mastoid muscle; in front it lies against the posterior border of the masseter and the ramus of the mandible and is continued for a variable distance over the surface of the masseter. Not unfrequently a small detached portion of the gland, the *accessory parotid gland* (socia parotidis) is seen upon the masseter muscle below the zygomatic arch. Between the posterior border of the ramus of the mandible and the posterior border of the internal pterygoid muscle a part of the gland passes forwards and is called the *pterygoid lobe.*

Relations.—The outer surface of the gland is covered by the skin, the superficial fascia and the deep fascia (parotideo-masseteric fascia) with some parotid lymph glands. Its inner surface is in relation with the styloid process

together with the muscles attached to it and the great vessels at the upper part of the neck, viz., the internal and external carotid arteries and the internal jugular vein. The gland is traversed by (1) the external carotid artery and its two terminal branches, the internal maxillary and the superficial temporal arteries, the latter emerging from the upper border of the gland near the zygomatic arch; (2) the transverse facial artery which emerges from its anterior border; (3) the zygomatic, buccal and mandibular branches of the facial nerve which emerge from its anterior border; (4) the temporal branches of the facial nerve which emerge from the front part of its upper border; (5) the cervical branch of the facial nerve which emerges from its lower border; (6) the auriculo-temporal nerve which accompanies the superficial temporal artery.

The **Parotid Duct** (Stenson's duct) appears at the anterior border of the gland and is about two inches long. It runs forwards below the zygomatic arch and across the masseter muscle and, reaching the anterior border of that muscle, dips inwards and perforates the buccinator muscle. Then it passes obliquely forwards between the buccinator and the mucous membrane of the mouth and opens into the mouth by a small orifice opposite the second molar tooth of the upper jaw. While crossing the masseter muscle it receives the duct of the accessory part of the gland.

Remove the parotid gland piecemeal at the same time tracing the structures which traverse it. Trace the branches of the facial nerve backwards through the substance of the gland. Trace the superficial temporal artery with its branches as it passes upwards to the temporal region in front of the ear. Verify the deep relations of the gland and the deep layer of the fascia colli which passes beneath the gland.

Vessels of the Face.—These are (1) the superficial

temporal artery and its branches, (2) the external maxillary artery and its branches, (3) the superficial temporal vein, and (4) the anterior facial vein.

The **Superficial Temporal Artery** is one of the terminal branches of the external carotid artery. It begins opposite the neck of the mandible in the substance of the parotid gland and runs upwards between the external acoustic meatus and the condyle of the mandible. Crossing the posterior root of the zygomatic arch it ascends upon the temporal fascia and divides into two terminal branches, the frontal and parietal, which have been studied during the dissection of the scalp. *Branches.*—(1) *Parotid branches* which are minute twigs supplying the parotid gland. (2) The *transverse facial artery* which arises in the substance of the parotid gland and runs horizontally forwards across the masseter muscle above the parotid duct and below the zygomatic arch. It divides into branches which supply the parotid gland and the masseter and anastomose with the external maxillary, infraorbital, masseteric and buccinator arteries. (3) The *anterior auricular branches* supply the anterior part of the pinna and the lobule of the ear. (4) The *middle temporal artery* arises above the zygomatic arch and piercing the temporal fascia, supplies the temporalis muscle and anastomoses with the deep temporal branches of the internal maxillary artery. (5) The *zygomatico-orbital artery* passes forwards above the zygomatic arch between the two layers of the temporal fascia to the lateral angle of the orbit, supplies the orbicularis oculi and anastomoses with the lacrimal and palpebral branches of the ophthalmic artery.

The *superficial temporal vein* receives tributaries corresponding to the branches of the superficial temporal artery and unites with the internal maxillary vein to form the posterior facial vein. *The posterior facial vein*

descends through the substance of the parotid gland and divides into two branches, an anterior and a posterior. The posterior branch unites with the posterior auricular vein to form the external jugular vein which has been already noticed. The anterior branch unites with the anterior facial vein to form the *common facial vein*.

External Maxillary Artery (Facial artery).—The second or facial portion of the external maxillary artery is now seen. It is extremely tortuous in its course. It appears on the face by crossing the body of the mandible and the antero-inferior angle of the masseter muscle. It then runs forwards and upwards to a point a little behind the angle of the mouth. Then it ascends to the medial palpebral commissure and terminates as the angular artery. It rests successively upon the mandible, the buccinator and the caninus. It is covered by the platysma, the risorius, the zygomaticus and the quadratus labii superioris. *Branches.*—(1) *Muscular.* These are given off to the masseter and buccinator and anastomose with the transverse facial branch of the superficial temporal artery. (2) The *inferior labial artery* (inferior coronary) arises below the angle of the mouth, passes forwards beneath the triangularis and then along the margin of the lower lip and supplies the muscles and skin of the lower lip. It anastomoses along the middle line with its fellow of the opposite side and with the mental branch of the inferior alveolar artery. (3) The *superior labial artery* (superior coronary artery) arises just above the preceding and passes medialwards along the upper lip between the orbicularis oris and the mucous membrane. It anastomoses with the artery of the opposite side and gives off the *septal artery* which ascends to the septum of the nose and supplies it as far as the tip of the nose. (4) The *lateral nasal artery* arises from the external maxillary artery when the parent trunk ascends along the side of

the nose. It supplies the ala and the dorsum of the nose and anastomoses with its fellow of the opposite side and with the dorsal nasal branch of the ophthalmic artery. (5) The *angular artery* is the terminal portion of the external maxillary artery. It ascends through the angular head of the quadratus labii superioris and terminates at the medial palpebral commissure by anastomosing with the dorsal nasal branch of the ophthalmic artery.

The **Anterior Facial Vein** (Facial vein) begins at the medial palpebral commissure as the angular vein, passes downwards and backwards with a less tortuous course than its companion artery, and lies behind the artery. It receives tributaries corresponding to the branches of the external maxillary artery and at its commencement receives the frontal and supraorbital veins. Over the buccinator muscle it receives the deep facial vein from the pterygoid venous plexus in the infratemporal region. Crossing the body of the mandible it pierces the deep fascia of the neck and appears in the submaxillary triangle. It unites with the anterior division of the posterior facial vein to form the common facial vein. This will be seen during the dissection of the anterior triangle of the neck.

The **Facial Nerve** gives off the following branches in the substance of the parotid gland :—

(1) The *temporal branches* which cross the zygomatic arch to gain the temporal region of the scalp. Their distribution has been noted (p. 224). (2) The *zygomatic branches* pass forwards above the parotid duct and across the zygomatic bone to the lateral angle of the orbit. They supply the orbicularis oculi and communicate with the lacrimal nerve and the zygomatico-facial branch of the maxillary nerve. The lowest branch unites with filaments from the buccal branch and the infraorbital nerve to form the *infraorbital plexus.* (3) The *buccal branches* pass forwards below the parotid duct towards

the angle of the mouth. The upper branches ascend beneath the zygomaticus and the quadratus labii superioris and form a plexus (*infraorbital plexus*) beneath the latter muscle with the infraorbital branch of the maxillary nerve and with the zygomatic branch of the facial nerve. These nerves and filaments from the plexus supply the muscles of the nose and the muscles of the upper lip. The lower branches supply the buccinator and the orbicularis oris and communicate with the buccinator branch of the mandibular nerve on the buccinator muscle. (4) The *mandibular branch* (inframaxillary branch) passes forwards and downwards beneath the triangularis and supplies the muscles of the lower lip and chin. Beneath the triangularis it communicates with the mental branch of the inferior alveolar nerve. (5) The *cervical branch* will be traced during the dissection of the anterior triangle of the neck.

Sensory Nerves of the Face.—The anterior branch of the great auricular nerve, the supraorbital and the supratrochlear nerves have already been examined. The *external nasal branch* (nasal nerve) is the terminal branch of the nasociliary nerve. It appears on the nose beneath the nasalis between the lower border of the nasal bone and the lateral nasal cartilage. It supplies the skin of the ala and tip of the nose. The *infratrochlear nerve* will be seen above the medial palpebral ligament. It is a branch of the nasociliary nerve and supplies the skin of the eyelids and the root of the nose. The *terminal branch of the lacrimal nerve* appears at the lateral part of the upper eyelid and supplies the skin at that part. The *infraorbital nerve* is the terminal part of the maxillary nerve. It emerges from the infraorbital foramen with the infraorbital vessels covered by the quadratus labii superioris. It immediately divides into inferior palpebral, external nasal and superior labial branches.

The *inferior palpebral branches* ascend and supply the skin and conjunctiva of the lower eyelid. The *external nasal branches* supply the skin of the side of the nose. The *superior labial branches* supply the skin and mucous membrane of the upper lip and communicate with the zygomatic and buccal branches of the facial nerve forming the infraorbital plexus. The *zygomatico-temporal nerve* has been examined during the dissection of the temporal region of the scalp. The *zygomatico-facial nerve* (malar branch of the temporo-malar nerve) emerges through a foramen in the zygomatic bone, pierces the orbicularis oculi, supplies the skin over the zygomatic bone and communicates with the zygomatic branches of the facial nerve. The *buccinator nerve* (long buccal nerve) appears beneath the anterior border of the masseter muscle. On the surface of the buccinator it communicates with the buccal branches of the facial nerve and supplies the skin over the buccinator. Some filaments pierce the buccinator to supply the mucous membrane of the mouth. The *mental nerve* is derived from the inferior alveolar branch of the mandibular nerve. It emerges with the mental vessels from the mental foramen of the mandible beneath the triangularis. It divides into three branches: two of them communicate with the mandibular branch of the facial nerve and supply the skin and mucous membrane of the lower lip, and one goes to supply the skin of the chin. The *auriculotemporal nerve* accompanies the superficial temporal artery lying just behind it. It gives off (1) the *anterior auricular branches* which are two small twigs and supply the skin of the tragus and front part of the helix; (2) *branches to the external acoustic meatus* which are two minute twigs and pass backwards to supply the skin of the external acoustic meatus; (3) the *parotid branches* which supply the parotid gland. Its terminal *temporal branches* in the scalp have been examined.

Nose.—The organ of smell is divisible into two portions, an external portion called the external nose and an internal portion, the nasal cavity, which is subdivided by a septum into the right and left nasal cavities. The external nose consists of a bony and a cartilaginous framework. The cartilaginous framework consists of five large pieces of cartilage—the two lateral, the two greater alar and the cartilage of the septum—and some small cartilaginous nodules. These are connected to each other as also to the bony framework by fibrous tissue.

Scrape away the remains of the muscles on the alæ of the nose. The *lateral cartilage* is triangular in shape. Its superior border is attached to the inferior border of the nasal bone and the frontal process of the maxillary bone by fibrous tissue. Its inferior border is connected with the greater alar cartilage by fibrous tissue. The upper part of its anterior border meets its fellow of the opposite side and the septal cartilage, but lower down a narrow interval is seen between the cartilages of the two sides. The *greater alar cartilage* is curved upon itself in such a way as to form the external orifice of the nostril medially, in front and laterally. Each piece presents a lateral crus and a medial crus. The lateral crus is oval with its long axis directed antero-posteriorly. Above it is attached to the lateral nasal cartilage by fibrous tissue. Behind it is attached to the frontal process of the maxilla by a fibrous membrane in which three or four small pieces of cartilages, called the lesser alar cartilages, are embedded. Its lower margin is free. The medial crus is narrow and lies in contact with the medial crus of the opposite side along the middle line connected by fibrous tissue. The *cartilage of the septum* will be studied during the dissection of the nasal cavity.

Structure of the Eyelids.—The eyelids are composed of the following strata arranged successively from without

inwards; (1) skin, (2) subcutaneous tissue, (3) the palpebral portion of the orbicularis oculi, (4) the tarsus, the medial palpebral ligament, the lateral palpebral raphe and the orbital septum--all lying in the same plane; the expanded aponeurosis of the levator palpebræ superioris present in the upper eyelid only, (5) tarsal glands, and (6) the conjunctiva. The first three strata have been already examined. To expose the fourth stratum, the palpebral portion of the orbicularis oculi is to be removed from the surface of the eyelids.

The **Tarsi** are thin plates of dense connective tissue which give shape to the eyelids. They are two in number, a superior in the upper eyelid and an inferior in the lower eyelid. The *superior tarsus* is the larger and of a semilunar shape. Its convex superior border and the adjoining outer surface gives attachment to the aponeurotic expansion of the levator palpebræ superioris and the orbital septum. Its inferior border is straight and covered by the skin at the free margin of the lid. The *inferior tarsus* is a narrow strip of almost equal breadth throughout. To its inferior border is attached the orbital septum. Its superior border is free. The medial ends of the tarsi are attached to the medial wall of the orbit by the *medial palpebral ligament* (tendo oculi). This ligament is attached medially to the frontal process of the maxilla in front of the lacrimal groove and laterally splits into two slips which are attached to the medial ends of the tarsi. The lateral ends of the tarsi are attached to the lateral walls of the orbit by the lateral palpebral raphe (external tarsal ligament). This ligamentous band is weaker than the medial palpebral ligament and is attached laterally to the fronto-sphenoidal process of the zygomatic bone; medially it splits into two slips for attachment to the lateral ends of the two tarsi.

The *orbital septum* or *palpebral fascia* is a membranous

process which fixes the tarsi to the margins of the orbit, where it is continuous with the periosteum. In the upper eyelid it blends with the aponeurosis of the levator palpebræ superioris and is attached to the superior border of the upper tarsus. In the lower eyelid it is attached to the inferior border of the lower tarsus. It is pierced by nerves and vessels which leave the orbit.

The *aponeurosis of the levator palpebræ superioris* as seen in the upper eyelid divides into three lamellæ. The superficial lamella blends with the orbital septum and is attached to the upper part of the anterior surface of the upper tarsus. The intermediate lamella is attached to the superior border of the upper tarsus and the deep lamella to the upper fornix of the conjunctiva.

The *tarsal glands* (Meibomian glands) are situated on the inner surface of the tarsi. If the eyelids are everted they are seen running in vertical yellow strings in grooves on the inner surface of the tarsi. The orifices of these glands are placed behind the eyelashes on the free margin of the lids.

The *palpebral conjunctiva* has been already examined.

Blood Vessels of the Eyelids.—These are the medial and lateral palpebral arteries. The *medial palpebral arteries*, two in number, are the branches of the ophthalmic artery. They pierce the orbital septum at the medial palpebral commissure and run lateralwards along the free margins of the eyelids; one in the upper and the other in the lower. They pass between the tarsus and the orbicularis oculi and anastomose with the lateral palpebral arteries forming an arch.

The *lateral palpebral arteries*, two in number, are the branches of the lacrimal artery. They pierce the orbital septum at the lateral palpebral commissure and pass medialwards along the free margins of the eyelids, one in the upper and the other in the lower. They anas-

tomose with the medial palpebral arteries forming an arterial arch.

The **Lacrimal Apparatus** consists of (1) the lacrimal gland with its excretory ducts, (2) the lacrimal ducts and (3) the lacrimal sac with the nasolacrimal duct.

Divide the orbital septum attached to the lateral half of the superior border of the upper tarsus. The lacrimal gland is exposed.

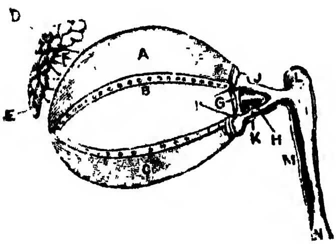


Fig. 65.--The lacrimal apparatus (Wilson).

A. Superior tarsus.
B. Lower border of the tarsus on which are seen the openings of the tarsal glands.
C. Inferior tarsus along the upper border of which are seen the openings of the tarsal glands.
D. Lacrimal gland, its superior portion.
E. Inferior portion of the gland.
F. Ducts of the lacrimal gland.
G. Plica semilunaris.
H. Caruncula lacrimalis.
I. Puncta lacrimalia.
J. Superior lacrimal duct.
K. Inferior lacrimal duct.
L. Lacrimal sac.
M. Nasolacrimal duct.
N. The duct opening into the inferior meatus of the nasal cavity.

The **Lacrimal Gland** lies in the lacrimal fossa at the front and lateral part of the roof of the orbit. Its upper surface is adapted to the concavity of the lacrimal fossa. Its under surface is in contact with the convexity of the eyeball. From its anterior border fine *excretory ducts*, six to twelve in number, emerge and open into the lateral part of the upper fornix of the conjunctiva.

The **Lacrimal Ducts** or **Canals** begin as minute orifices, called *puncta lacrimalia*, on the free margins of the eyelids at the lateral extremity of the lacus lacrimalis. The *superior duct*, the shorter and narrower of the two, at first ascends and then proceeds medialwards and

slightly downwards to open into the lacrimal sac. The *inferior duct* at first descends and then proceeds horizontally medialwards to open into the lacrimal sac. Bristles may be passed through the puncta lacrimalia to the lacrimal sac through these ducts.

The **Lacrimal Sac** is the dilated upper portion of the nasolacrimal duct. It is oval in shape and lies in the lacrimal groove behind the medial palpebral ligament. Its upper end is closed while below it is continued as a narrow duct called the nasolacrimal duct. The lacrimal canals open into its antero-lateral part.

The *naso-lacrimal duct* (nasal duct) is the continuation downwards of the lacrimal sac into the anterior part of the inferior meatus of the nasal cavity. It lies in the bony canal formed by the lacrimal bone, the frontal process of the maxilla and the lacrimal process of the inferior nasal concha. It is about half an inch in length. It is directed from above downwards, lateralwards and backwards. This may be ascertained by passing a fine probe through it.

The *lacrimal part of the orbicularis oculi* (tensor tarsi) may now be studied. It arises from the posterior aspect of the lateral part of the medial palpebral ligament and passes backwards and medialwards to be inserted into the lacrimal crest of the lacrimal bone.

THE ANTERIOR TRIANGLE OF THE NECK.

The student should now proceed to dissect the anterior triangle of the neck. The head is made to hang freely over the edge of the table and the mandible fixed with hooks. The superficial nerves are to be reflected backwards and the superficial layer of the fascia colli stretching across the anterior triangle removed.

The **Anterior Triangle** is bounded in front by the

median line of the neck; behind by the anterior margin of the sterno-cleido-mastoideus. Its base is above, being formed by the lower border of the body of the mandible and a line drawn from its angle to the mastoid process. Its apex is below at the sternum. This triangle is subdivided into three smaller triangles by the superior belly of the omohyoideus and the two bellies of the digastric muscle. The three triangles are named from above downwards the submaxillary, the carotid and the muscular triangles.

Some of the processes given off from the deep surface of the fascia colli should now be examined and then the student should proceed to expose fully the divisions and contents of the anterior triangle.

Pretracheal Fascia.—This layer arises from the deep surface of the fascia which lines the posterior surface of the sterno-cleido-mastoideus. It passes medialwards in front of the carotid arteries and the internal jugular vein forming a part of their sheath (carotid sheath). Further in front it passes behind the sternohyoid and sterno thyreoid muscles and in front of the thyreoid gland and the trachea. Above it is attached to the body of the hyoid bone and below it is prolonged downwards into the thoracic cavity behind the sterno-thyreoid and sterno-hyoid muscles where it blends with the fibrous layer of the pericardium.

The **Carotid Sheath** is the fascial envelope which contains the carotid arteries, the internal jugular vein and the vagus nerve. It is formed in front by the pretracheal fascia, behind by the prevertebral fascia and medially by a fascial process connecting the pretracheal with the prevertebral fascia.

The **Carotid Triangle** is bounded above by the posterior belly of the digastric muscle, below by the superior belly

of the omohyoideus and behind by the anterior margin of the sterno-cleido-mastoideus.

The structures seen in this triangle are now to be exposed fully. The carotid sheath is to be laid open longitudinally, taking care of the descendens hypoglossi nerve which lies either in front of the sheath or embedded in its anterior wall. The contents of the sheath, viz., the carotid arteries, the internal jugular vein and the vagus nerve are to be separated from one another. The carotid arteries lie medially, the internal jugular vein laterally and the vagus nerve behind and between them. The sympathetic nerve trunk is seen embedded in the posterior wall of the carotid sheath. The common carotid bifurcates into the external and internal carotid arteries at the level of the upper border of the thyreoid cartilage. The external carotid artery lies on a plane medial to and anterior to the internal carotid artery. The branches given off within this triangle from the external carotid artery are to be cleaned; the superior thyreoid artery arises from its anterior aspect; above it are the origins of the lingual and external maxillary arteries; the occipital artery arises from its posterior aspect, while the ascending pharyngeal artery passes vertically upwards from its medial aspect close to the commencement of the parent trunk. While cleaning the external carotid artery note that it is surrounded by filaments from the sympathetic which form a plexus around it. From this plexus subsidiary plexuses are prolonged on the branches of the external carotid artery. The branch of superior internal laryngeal nerve is seen to pierce the hyo-thyreoid membrane and enters the larynx. Traced laterally it leads to the superior laryngeal nerve which emerges from behind the internal carotid artery at the side of the pharynx. The external laryngeal branch of the superior laryngeal of vagus nerve is seen passing downwards by the side of the pharynx to supply


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Fig. 66.—Deep dissection of the triangles of the neck (from Maclise's Surgical Anatomy).

A. Right sterno-cleido-mastoideus (cut).
B. Left sterno-cleido-mastoideus.
C. Upper part of sterno-cleido-mastoideus.
D. Superior belly of omo-hyoid.
E. Inferior belly of omo-hyoid.
F. Scalenus anterior with phrenic nerve.
G. Sterno-hyoid.
H. Sterno-thyreoid.
I. Mylo-hyoid (turned down).
J. Levator scapulæ.
K. Scalenus posterior.
L. Genio-hyoid.
M. Trapezius.
N. Parotid duct.
O. Clavicle.
1. Innominate artery.
2. Right subclavian artery.
3. Right common carotid artery.
4. External carotid artery.
5. Internal carotid artery.
6. Lingual artery.
7. External maxillary artery.
8. Continuation of external carotid artery.
9. Occipital artery.
10. Internal jugular vein.
11. Subclavian artery (third part).
12. Descending branch of transverse cervical artery.
13. Transverse scapular artery.
14. Transverse cervical artery.
15. Transverse scapular vein.
16. Subclavian vein.
18. Superior thyreoid artery.
19. Vagus nerve.
20. Accessory nerve.
21. Cervical plexus (cut).
22. Brachial plexus.
23. Hypoglossal nerve on hyoglossus.

the crico-thyreoid muscle. The hypoglossal nerve crosses the carotid arteries from without inwards by hooking round the occipital artery. It gives off the descendens hypoglossi branch in front of the carotid sheath and its thyreohyoid branch goes to supply the thyreo-hyoid muscle. At the upper part of the triangle the accessory nerve runs downwards and backwards under cover of the posterior belly of the digastricus and pierces the sterno-cleido-mastoideus at its upper part. Note the lymph glands lying along the course of the internal jugular vein and the carotid arteries. These are called the *superior deep cervical lymph glands*. A small oval body called the glomus caroticus is seen lying behind the point of bifurcation of the common carotid artery.

The *contents* of the carotid triangle may be enumerated as follows :—

1. Portions of all the three carotid arteries, viz., the

common carotid, the external carotid and the internal carotid.

2. The superior thyreoid, lingual, external maxillary, occipital and the ascending pharyngeal branches of the external carotid artery.

3. The internal jugular vein and some of its tributaries, viz., the common facial, lingual, superior and middle thyreoid veins.

4. The vagus nerve with its superior laryngeal branch (dividing into external and internal laryngeal nerves), the accessory nerve, the hypoglossal nerve with its descendens hypoglossi and thyreo-hyoid branches, and the sympathetic nerve trunk.

5. Portions of the larynx, pharynx and hyoid bone.

6. Glomus caroticus.

7. Lymph glands and vessels.

The **Submaxillary or Digastric Triangle** is *bounded* above by the lower border of the mandible and a line joining its angle to the mastoid process, below by the posterior belly of the digastric and the stylo-hyoideus, in front by the anterior belly of the digastric.

The submaxillary gland is seen exposed under the lower jaw. The external carotid artery reaches the posterior part of the triangle and gives off its posterior auricular branch. The external maxillary artery passes through the submaxillary gland and reaches the groove in the mandible in front of the anterior margin of the masseter. Its branches given off in the neck should be traced. The anterior facial vein passes superficial to the submaxillary gland. The mylohyoid nerve accompanies the mylohyoid artery and lies on the surface on the mylohyoideus. Several lymph glands are seen beneath the lower border of the mandible and on the surface of the submaxillary gland. The internal carotid artery, the internal jugular vein, the glosso-pharyngeal and vagus

nerves are placed deeply in the posterior part of the triangle. A small part of the hypoglossal nerve is also seen.

The *contents* of the submaxillary triangle may be thus enumerated :—

1. The external carotid artery with its posterior auricular branch; the external maxillary artery with its cervical branches, viz., the ascending palatine, tonsillar, glandular and submaxillary branches; the mylohyoid artery; the internal jugular and the anterior facial veins.

2. The glossopharyngeal, vagus and hypoglossal nerves; and the mylohyoid nerve.

3. The submaxillary gland; lower portion of the parotid gland and lymph glands.

The **Muscular Triangle** is bounded in front by the medial line of the neck, behind by the anterior margin of the sterno-cleido-mastoideus, and above by the superior belly of the omohyoideus.

Define the sterno-hyoideus and sterno-thyreoideus muscles. The former is placed superficially covering the latter muscle. The superior thyreoid artery is seen to descend beneath these muscles to end in the thyreoid gland. Nerve filaments for the supply of these muscles will be seen coming from the ansa hypoglossi or the loop formed by the descendens hypoglossi with the communicantes cervicales from the second and third cervical nerves. The external laryngeal nerve should be traced to its termination in the cricothyreoid muscle. The recurrent nerve is placed in the groove between the trachea and œsophagus. Beneath the sterno-hyoid and sterno-thyreoid muscles are seen the larynx, the trachea and the thyreoid gland.

The contents of the muscular triangle may be enumerated thus :—

1. The sterno-hyoid and sterno-thyreoid muscles.

2. The superior thyreoid artery.

3. The recurrent and external laryngeal nerves; twigs from the ansa hypoglossi to the sterno-hyoid and sterno-thyreoid muscles.

4. The greater portion of the larynx, the trachea, the thyreoid gland and the œsophagus.

The **Submental or Suprahyoid Triangle** is another triangular space often described in connection with the subdivisions of the anterior triangle of the neck. It is *bounded* laterally by the anterior belly of the digastricus, above by the mandible, and in front by the middle line of the neck. Its apex is at the body of the hyoid bone. In this space are seen one or two lymph glands and some minute veins which are the radicles of the anterior jugular vein.

The dissector should now proceed to study each one of the structures in its entirety as exposed in the different divisions of the anterior triangle of the neck.

The **Descendens Hypoglossi Nerve** issues as the hypoglossal nerve hooks round the occipital artery. It descends in front of or is embedded in the anterior wall of the carotid sheath and reaching the middle of the neck joins the communicantes cervicales from the second and third cervical nerves to form a loop, called the *ansa hypoglossi*. Before forming a loop it gives a twig to the superior belly of the omohyoid and from the loop itself branches are given off to the inferior belly of the omo-hyoid, sterno-hyoid and sterno-thyreoid muscles.

The **Omohyoideus** consists of a superior and an inferior muscular belly and an intermediate tendon. The origin of the inferior belly has been seen (p. 249). It subdivides the posterior triangle into the occipital and subclavian triangles. Beneath the sterno-cleido-mastoideus it ends in the intermediate tendon. From this tendon the superior belly passes upwards and medialwards to be

inserted into the lower border of the body of the hyoid bone lateral to the insertion of the sterno-hyoideus. The process of the fascia colli which descends from its inferior belly and the intermediate tendon has been examined. *Nerve-supply.*—The superior belly is supplied by a twig from the descendens hypoglossi. The twig which enters the inferior belly comes from the ansa hypoglossi.

The **Sterno-hyoideus** is a thin flat muscle which arises (1) from the medial end of the posterior surface of the clavicle, (2) from the articular capsule of the sterno-clavicular joint, and (3) from the posterior surface of the manubrium sterni. It is inserted into the lower border of the body of the hyoid bone just medial to the insertion of the omohyoideus. It is supplied by a branch from the ansa hypoglossi.

Divide the sterno-hyoideus at its middle and reflect the divided ends upwards and downwards. The sterno-thyreoideus and thyreo-hyoideus are exposed.

The **Sterno-thyreoideus** is broader but shorter than the sterno-hyoideus. It arises from the posterior surface of the manubrium sterni below the origin of the sterno-hyoideus and from the adjoining cartilage of the first rib. It is inserted into the oblique line on the lateral surface of the lamina of the thyreoid cartilage. A branch from the ansa hypoglossi supplies this muscle.

The **Thyreohyoideus** is practically the prolongation upwards of the preceding muscle above the oblique line on the lateral surface of the lamina of the thyreoid cartilage from which it arises. It is inserted into the lower border of the greater cornu of the hyoid bone. It is supplied by a slender filament from the hypoglossal nerve.

The **Digastricus** consists of two muscular bellies and an intermediate tendon. The anterior belly arises from a depression on the inner side of the lower border of the mandible close to the symphysis menti. The posterior

belly arises from the mastoid notch on the medial side of the mastoid process of the temporal bone. The intermediate tendon pierces the insertion of the stylohyoideus, and is attached to the side of the body of the hyoid bone by a fibrous loop derived from the fascia colli. The anterior belly is supplied by the mylohyoid branch of the inferior alveolar nerve; the posterior belly by the facial nerve.

The **Stylohyoideus** is a slender muscle which arises from the lateral and back part of the styloid process near its root. It is inserted into the body of the hyoid bone at its junction with the greater cornu. The tendon of the digastricus pierces this muscle near its insertion. Its nerve supply from the facial nerve will be seen later on.

Cut the sterno-cleido-mastoideus at its attachment to the sternum and clavicle. Reflect the muscle upwards as far as practicable without destroying the vessels and nerve filaments entering it. Dissect fully the contents of the carotid sheath which lie under cover of the muscle. Next clean the scaleni muscles. These are three in number, anterior, middle and posterior.

The **Scalenus Anterior** arises from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ. It is inserted into the scalene tubercle on the inner border and upper surface of the first rib. It lies immediately behind the clavicular head of the sterno-cleido-mastoideus which has now been reflected. A large number of important structures are seen to be in relation with this muscle. Thus *in front* the phrenic nerve crosses it obliquely from the lateral to the medial side, while the transverse scapular and the transverse cervical vessels, the subclavian vein and the omohyoideus cross it more or less transversely. *Behind* the muscle are seen the second part of the subclavian artery and the brachial plexus of nerves. Along its

medial margin, the internal jugular vein descends to unite with the subclavian vein in front of the muscle. The thyreocervical trunk with its inferior thyreoid branch and the vertebral artery also lie medially.

The **Scalenus Medius,** the largest of the three scaleni, arises from the posterior tubercles of the transverse processes of the lower six cervical vertebræ and is inserted into a rough impression on the upper surface of the first rib extending from the groove for the subclavian artery to the tubercle of the rib.

The **Scalenus Posterior,** the smallest of the three scaleni, arises from the posterior tubercles of the lower two or three cervical vertebræ and is inserted into the outer surface of the second rib just behind the attachment of the serratus anterior.

The scaleni are supplied by twigs from the second to the seventh cervical nerves.

The **Subclavian Artery** begins on the right side from the bifurcation of the innominate artery behind the right sterno-clavicular joint and on the left side from the arch of the aorta. The left vessel has therefore an additional intrathoracic portion which has been examined (p. 194). It is customary to divide the vessel into three portions: the first portion extends from the origin of the vessel to the medial margin of the scalenus anterior; the second portion lies behind that muscle; and the third portion extends from the lateral margin of the scalenus anterior to the outer border of the first rib. The first portion of the vessel presents differences in its relations on the two sides of the body, while the second and third portions exhibit same relations on the two sides. Sympathetic nerve filaments surround the subclavian artery and are prolonged on its branches.

First portion.—The first portion of the right vessel corresponds in position to the cervical part of the first

portion of the left vessel. The relations of the thoracic part of the left subclavian artery have been examined during the dissection of the thorax. On the right side the artery runs upwards and lateralwards from its commencement to the medial margin of the scalenus anterior. On the left side the artery passes almost directly lateralwards from the root of the neck to the medial border of the scalenus anterior. The common relations to the arteries of both sides are :—*in front*, with the skin, superficial fascia, platysma and deep fascia ; with three muscles —the sterno-cleido-mastoideus, the sterno-thyreoideus and the sterno-hyoideus ; with three veins—the internal jugular, the anterior jugular, and vertebral veins ;

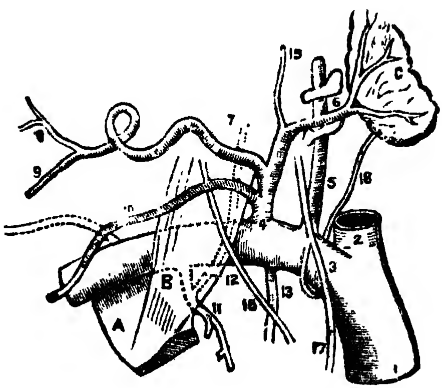


Fig. 67.—Diagram of the subclavian artery and its branches (Turner).

A. First rib.
B. Scalenus anterior.
C. Thyreoid body.
1. Innominate artery.
2. Right common carotid artery.
3. Right subclavian artery.
4. Thyreo-cervical trunk.
5. Vertebral artery.
6. Inferior thyreoid artery.
7. Transverse cervical artery.
8. Its ascending branch.
9. Its descending branch.
10. Transverse scapular artery.
11. Superior intercostal artery.
12. Arteria profunda cervicis.
13. Internal mammary artery.
15. Ascending cervical artery.
16. Phrenic nerve.
17. Vagus nerve.
18. Right recurrent nerve.

and with the vagus nerve, its cardiac branches and the cardiac branches of the sympathetic nerve. **Behind** it is the sympathetic trunk, as also the longus colli and the cervical pleura.

Relations peculiar on the two sides:—**on the right side** the artery is encircled by a loop of the sympathetic trunk and the right recurrent nerve hooks below and behind the artery. On the left side the phrenic nerve and the left innominate vein lie in front of it and the thoracic duct lies at first medial to the artery and then arches above it.

Second portion.—This part is covered by (1) the superficial structures, viz., the skin, superficial fascia, platysma and deep cervical fascia, (2) clavicular head of sterno-cleido-mastoideus, (3) the phrenic nerve (on the right side), (4) the scalenus anterior, (5) the subclavian vein. The phrenic nerve owing to its greater obliquity on the left side becomes related to the first portion of the vessel on the left side and not to the second portion. The subclavian vein lies on a slightly lower level and separated from the artery by the scalenus anterior. Behind and below the artery is the pleura.

Third portion.—This part of the artery has been described (p. 289).

Branches of the Subclavian Artery.—These are four in number, viz., (1) vertebral, (2) thyreocervical trunk, (3) internal mammary, (4) costocervical trunk.

The **Vertebral Artery** issues from the upper and back part of the first portion of the subclavian artery. It passes upwards between the contiguous borders of the scalenus anterior and longus colli and enters the foramen in the transverse process of the sixth cervical vertebra. It lies under cover of the vertebral and internal jugular veins and is crossed by the thoracic duct on the left side. The remaining part of

its course in the neck will be studied later on. The *vertebral vein* after its exit from the foramen in the transverse process of the sixth cervical vertebra opens into the innominate vein at its commencement.

The **Thyreocervical Trunk** (Thyreoid axis) is a short vessel which arises from the front aspect of the first portion of the subclavian artery close to the medial border of the scalenus anterior and divides almost immediately into three terminal branches, viz., the inferior thyreoid, the transverse cervical and the transverse scapular.

The **Inferior Thyreoid Artery** runs at first upwards in front of the vertebral artery and the longus colli. Then it turns medialwards behind the internal jugular vein, the common carotid artery, the vagus nerve and the sympathetic trunk to reach the posterior border of the thyreoid gland. It then descends along this border to the lower end of the gland. It gives off the following branches: (1) the *ascending cervical* which runs upwards between the contiguous borders of the scalenus anterior and the longus capitis. It gives off twigs to the prevertebral muscles and one or two *spinal branches* which enter through the intervertebral foramina. The distribution of these spinal branches to the medulla spinalis and its membranes has been examined. (2) The *inferior laryngeal artery* which passes in company with the recurrent nerve to supply the muscles and mucous membrane of the larynx. (3) The *tracheal branches* which supply the trachea and anastomose with the bronchial arteries. (4) The *œsophageal branches* supply the œsophagus and anastomose with the œsophageal branches of the thoracic aorta. (5) The *glandular branches* are usually two in number, an ascending branch which supplies the posterior part of the thyreoid gland and an inferior branch which supplies its lower end. They anastomose with the superior thyreoid artery and with the artery of the

opposite side. (6) The *muscular branches* are small twigs which supply the neighbouring muscles. The *inferior thyreoid vein* does not run along with the artery. It emerges from the thyreoid body and descends in front of the trachea and beneath the sterno-thyreoid muscle to enter the thorax. Its termination in the innominate vein has been examined (p. 193). Its tributaries correspond to the inferior laryngeal, tracheal and œsophageal branches of the inferior thyreoid artery. The companion vein of the ascending cervical artery is called the *anterior vertebral vein* and terminates in the vertebral vein.

The **Transverse Cervical Artery** runs lateralwards across the scalenus anterior, the phrenic nerve and the brachial plexus and is covered by the sterno-cleido-mastoideus. Its further course has been examined (p. 289).

The **Transverse Scapular Artery** is placed on a lower level than the transverse cervical artery. It runs lateralwards along the root of the neck under cover of the sterno-cleido-mastoideus across the lower end of the scalenus anterior, the phrenic nerve, the subclavian artery and the brachial plexus. Its course up to the upper border of the scapula has been examined (p. 290). The *transverse cervical* and *transverse scapular veins* open into the external jugular vein.

The **Internal Mammary Artery** arises from the lower aspect of the first portion of the subclavian artery just opposite the thyreo-cervical trunk. In the neck it is covered by the subclavian vein and is crossed by the phrenic nerve from the lateral to the medial side. Its thoracic portion has been described (p. 153). Its companion vein terminates in the innominate vein (p. 193).

The **Costocervical Trunk** (Superior intercostal artery) arises from the posterior aspect of the second portion of the subclavian artery close to the medial border of the

scalenus anterior on the right side. On the left side it springs from the first portion of the parent trunk. It passes backwards above the dome of the cervical pleura towards the neck of the first rib and divides into the arteria cervicalis profunda and the arteria intercostalis suprema. The *arteria cervicalis profounda* runs backwards to the back part of the neck between the transverse process of the seventh cervical vertebra and the neck of the first rib. Its further course has been studied (p. 261). The *deep cervical vein* opens into the vertebral vein. The *arteria intercostalis suprema* runs downwards in front of the necks of the first and second ribs and anastomoses with the first aortic intercostal artery. Its branches to the first two intercostal spaces have been examined (p. 210). The intercostal veins corresponding to the arteries in the first two intercostal spaces have been examined (p. 212).

The **Subclavian Vein** is the continuation of the axillary vein. It begins at the outer border of the first rib and ends behind the medial end of the clavicle where it joins the internal jugular vein to form the innominate vein. Below it lies upon a groove on the first rib. Above and behind it is the subclavian artery from which it is separated by the scalenus anterior and the phrenic nerve. *Tributaries.* The external jugular vein opens into it and at its junction with the internal jugular vein it receives the right lymphatic duct on the right side and the thoracic duct on the left side.

Thoracic Duct.—Its cervical portion is now to be examined. After its exit from the upper opening of the thorax it appears at the root of the left side of the neck lying between the œsophagus and the cervical pleura. Then it arches lateralwards behind the common carotid artery, the vagus nerve and the internal jugular vein above the arch formed by the subclavian artery. It

then turns downwards in front of the subclavian artery to open into the angle of junction of the internal jugular vein with the subclavian vein. At its termination it is guarded by a pair of valves.

Tributaries of the cervical part of the thoracic duct.—These are: (1) the *left jugular trunk* draining lymph from the left side of the head and neck; (2) the *left subclavian trunk* draining lymph from the left superior extremity; and (3) the left *bronchomediastinal trunk* draining lymph from the left side of the thorax.

The Right Lymphatic Duct corresponds on the right side to the thoracic duct on the left side. It is about half an inch in length and passes along the medial border of the scalenus anterior to open into the angle of junction of the right internal jugular and right subclavian veins. It is formed by the union of (1) the *right jugular trunk* which drains lymph from the right side of the head and neck; (2) the *right subclavian trunk* which drains lymph from the right superior extremity; and (3) the *right broncho-mediastinal trunk* (p. 205).

The **Cervical Pleura** has been described (p. 159). Its relations may now be examined. It is completely covered by Sibson's fascia. It is covered antero-laterally by the scalenus anterior; a few fibres of the muscle spread over and stengthen it. The subclavian artery crosses the cervical pleura below its apex. The costocervical trunk crosses the apex and its superior intercostal branch lies posterior to the apex.

The sterno-clavicular articulation should now be studied.

The **Sterno-Clavicular Articulation** is an arthrodial joint. The parts entering into the formation of the joint are the sternal end of the clavicle, the articular surface situated on the upper and lateral part of the manubrium sterni and the first costal cartilage. The following are

its ligaments: (1) The *articular capsule* which surrounds the articular surfaces of the clavicle and manubrium sterni. It is of varying thickness and strength and is attached to the margin of the articular disc interposed between the articular surfaces. (2) The *sternoclavicular ligament* strengthens the joint in front. It extends obliquely from the upper part of the anterior aspect of the sternal facet to the upper and front part of the sternal end of the clavicle. (3) The *interclavicular ligament* strengthens the articular capsule above. It extends from the upper part of the sternal end of one clavicle along the bottom of the jugular notch of the sternum to the corresponding point on the clavicle of the opposite side. (4) The *costoclavicular ligament* (Rhomboid ligament) is attached below to the upper surface of the first costal cartilage, and above to the costal tuberosity on the undersurface of the medial end of the clavicle. (5) The *articular disc* is placed between the articular surfaces of the sternum and clavicle. It is flat and almost circular. It is attached above to the upper part of the posterior border of the articular surface of the clavicle and below to the cartilage of the first rib at its union with the sternum. By its circumference it is attached to the articular capsule. Each surface of the articular disc is lined by a synovial stratum.

The **Common Carotid Artery** begins on the right side behind the right sterno-clavicular articulation at the bifurcation of the innominate artery, while on the left side it springs from the arch of the aorta. On each side the vessel terminates on a level with the upper border of the thyreoid cartilage by dividing into the external and internal carotid arteries. The left artery has therefore an additional intrathoracic portion (p. 194). The right common carotid artery and the cervical portion of the left common carotid artery resemble each other closely in their rela-

tions. At the lower part of the neck the common carotid arteries are deeply placed and are separated from each other by the trachea and œsophagus. At the upper part of the neck they are more superficial and are separated from each other by the thyreoid cartilage and the pharynx. Each artery is contained in the carotid sheath, the contents of which and their relative positions have been examined. The structures lying *in front* of the vessel are ;—the skin, superficial fascia, platysma, fascia colli and the sterno-cleido-mastoideus (throughout the entire length of the vessel) ; the descendens hypoglossi and the branches from the ansa hypoglossi descend in front of the sheath of the vessel ; the sterno-hyoid and sterno-thyreoid muscles lie in front of it (at its lower part), the omohyoid muscle passes over it opposite the cricoid cartilage ; the sterno-cleido-mastoid branch of the superior thyreoid artery, the superior and middle thyreoid veins cross the vessel from the medial to the lateral side. *Behind* it are the longus colli and capitis, the inferior thyreoid artery, the sympathetic trunk, the recurrent nerve (on the right side) and the thoracic duct on the left side. To its *lateral side* are the internal jugular vein and the vagus nerve, while on its *medial side* are the larynx and trachea, the pharynx and the œsophagus, the inferior thyreoid artery, the recurrent nerve and the thyreoid gland. No branches are given off from the common carotid artery.

Glomus Caroticum (Carotid body).—This is a small reddish brown, oval body seen on the posterior aspect of the common carotid artery at the point of its bifurcation. It is closely connected with filaments derived from the sympathetic plexus around the carotid artery. Its function is unknown.

The **External Carotid Artery** begins opposite the upper border of the thyreoid cartilage at the bifurcation of the common carotid artery and ends in the substance

of the parotid gland behind the neck of the mandible by dividing into two terminal branches, viz., the superficial temporal and internal maxillary arteries. At its commencement it lies medial to and more superficial than the internal carotid artery. Here it is contained in the carotid triangle and has *in front* of it the deep fascia and the anterior margin of the sterno-cleido-mastoideus. It is crossed by the lingual and common facial veins and the hypoglossal nerve. Higher up as it enters the posterior part of the submaxillary triangle it is crossed by the digastric and stylohyoid muscles. Still higher up where it enters the substance of the parotid gland it lies beneath the facial nerve and the posterior facial vein. *Behind the artery*, near its commencement are the superior laryngeal nerve, the stylo-glossus and stylo-pharyngeus muscles which separate it from the internal carotid artery and the glossopharyngeal nerve. *Lateral* to it is the internal carotid artery while *medially* are the pharynx, and the superior laryngeal nerve dividing into internal and external laryngeal branches and the posterior border of the ramus of the mandible.

Branches. The branches of the external carotid artery may be grouped as follows :—

Anterior.	*Posterior.*	*Ascending.*
Superior thyreoid.	Occipital.	Ascending pharyngeal.
Lingual.	Posterior auricular.	Superficial temporal.
External maxillary.		
Internal maxillary.		

The **Superior Thyreoid Artery** is the first of the anterior branches of the external carotid. It arises just below the greater cornu of the hyoid bone and passes forwards and downwards beneath the omohyoid, sternohyoid and

sternothyreoid muscles to end in the thyreoid gland. It gives off the following branches :—(1) The *hyoid branch* which passes along the lower border of the hyoid bone beneath the thyreohyoid muscle, supplies the muscle and anastomoses with its fellow of the opposite side. (2) The *sterno-cleido-mastoid artery* which passes obliquely downwards and backwards across the carotid sheath to enter the substance of the sterno-cleido-mastoideus. (3) The *superior laryngeal artery* passes in company with the internal laryngeal nerve beneath the thyreohyoid muscle and pierces the hyothyreiod membrane to supply the interior of the larynx. (4) The *cricothyreoid branch* runs transversely medialwards across the cricothyreoid ligament and anastomoses with the artery of the opposite side. (5) The *glandular branches* are the terminal branches which are two or three in number and supply both surfaces of the thyreoid gland ; one of these passes along the isthmus of the thyreoid gland to anastomose with its fellow of the opposite side.

The *superior thyreoid vein* begins in the thyreoid gland, receives tributaries corresponding mostly to the branches of the artery and terminates in the internal jugular vein.

The **Lingual Artery** arises above the origin of the superior thyreoid artery opposite the greater cornu of the hyoid bone. It at first ascends and then bends downwards forming a loop and passes beneath the digastricus and stylohyoideus. It then runs forwards beneath the hyoglossus muscle, at the posterior border of which it gives off the *hyoid branch*, which passes medialwards along the upper border of the hyoid bone, supplies the neighbouring muscles and anastomoses with its fellow of the opposite side. The rest of the course of the artery and its other branches will be examined at a later stage of dissection.

The **External Maxillary Artery** (Facial artery) arises

from the external carotid above the origin of the lingual artery and may be divided into two portions. The first or *cervical portion*, extending from the origin of the artery to the groove in the mandible at the antero-inferior angle of the masseter muscle; and the second or *facial portion* which has been already studied. The cervical portion of the artery runs upwards and forwards and is at first contained in the carotid triangle; then it passes under the posterior belly of the digastric and stylohyoid muscles and reaches the submaxillary triangle where it is embedded in the posterior part of the submaxillary gland. The following branches (*cervical branches*) are given off in the neck :—(1) the *ascending palatine artery* which passes upwards along the lateral wall of the pharynx between the stylo-glossus and stylopharyngeus muscles. Its terminal branches which enter the pharynx cannot be examined now. (2) The *tonsillar branch* passes upwards between the styloglossus and the pterygoideus internus and pierces the pharyngeal wall to supply the tonsil and back part of the tongue. (3) The *glandular branches* supply the submaxillary gland. (4) The *submental artery* runs forwards upon the mylohyoid muscle below the lower border of the mandible. Near the symphysis menti it turns upwards over the chin to supply the lower lip and anastomose with the mental and inferior labial arteries. In its course it supplies the submaxillary lymph glands, the mylohyoid muscle and anastomoses with the sublingual artery by piercing the muscle. It also anastomoses with the mylohyoid branch of the inferior alveolar artery.

Anterior Facial Vein (Facial vein).—Its facial portion has been examined. Its cervical portion receives tributaries corresponding to the branches of the cervical portion of the external maxillary artery and unites with the anterior division of the posterior facial vein to form

the *common facial vein* which opens into the internal jugular vein.

The **Occipital Artery** arises from the back part of the external carotid opposite the origin of the external maxillary artery. It runs upwards and backwards along the lower border of the posterior belly of the digastric to reach the space between the transverse process of the atlas and the mastoid process of the temporal bone. Its further course in the scalp has been already examined. The artery presents three stages in its course. The first stage lies in front of the sterno-cleido-mastoid muscle. Here it crosses the internal carotid artery, internal jugular vein, the vagus and accessory nerves while the hypoglossal nerve hooks round the vessel from behind forwards. The second stage lies behind the sterno-cleido-mastoid, splenius capitis, longissimus capitis and digastric muscles. The third stage constitutes the portion which ramifies in the scalp (p. 223). The *branches* from the first stage are: (1) the *sterno-cleido-mastoid branch* which passes downwards and backwards and enters the sterno-cleido-mastoid muscle in company with the accessory nerve. (2) The *meningeal branch* which accompanies the internal jugular vein and enters the posterior fossa of the skull through the jugular foramen where it supplies the dura mater.

The *occipital vein* usually joins the deep cervical and vertebral veins; occasionally it opens into the internal jugular vein.

The **Posterior Auricular Artery** arises from the external carotid artery above the posterior belly of the digastric. At first it is placed deeply and runs upwards and backwards under cover of the parotid gland, over the styloid process of the temporal bone and reaches the interval between the mastoid process and the cartilage of the external ear. Here its terminal branches have been

examined during the dissection of the scalp (p. 228). Besides those terminal branches it gives off (1) *muscular branches* to the neighbouring muscles, (2) *glandular branches* to the parotid gland and (3) the *stylomastoid artery* which enters the stylomastoid foramen, supplies the mastoid cells and the tympanic cavity and anastomoses in the facial canal with the petrosal branch of the middle meningeal artery.

The *posterior auricular vein* has been seen to unite with the posterior division of the posterior facial vein near the angle of the mandible to form the external jugular vein.

The **Ascending Pharyngeal Artery** issues from the external carotid near its origin. It passes upwards between the internal carotid artery and the lateral wall of the pharynx. It will be examined again during the deep dissection of the neck.

The **Superficial Temporal Artery** has been examined during the dissection of the face (p. 306).

The **Internal Maxillary Artery** will be examined during the dissection of the infratemporal region.

Cervical Plexus.—During the dissection of the neck the student has met with the various branches of the cervical plexus. This plexus is formed by the anterior divisions of the upper four cervical nerves and lies between the sterno-cleido-mastoideus in front and the scalenus medius behind. The anterior divisions of the second, third and fourth cervical nerves divide each into an ascending and a descending branch which unite with each other forming loops. The ascending branch of the second cervical nerve joins the undivided anterior division of the first cervical nerve above, while the descending branch of the fourth cervical nerve joins the fifth nerve below to enter into the formation of the brachial plexus. The cervical plexus consists of three loops ; the first loop

is formed by the first and second cervical nerves, the second loop by the second and third nerves; and the

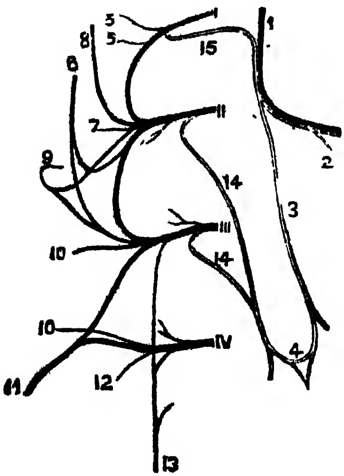


Fig. 68.—Diagram of the cervical plexus (Cunningham).

I, II, III, IV Anterior primary divisions of the upper four cervical nerves.
1. **Hypoglossal nerve.**
2. **Thyreo-hyoid nerve.**
3. **Descendens hypoglossi.**
4. **Ansa hypoglossi.**
5. **Branches to recti.**
6. **Great auricular nerve.**
7. **Branch to sterno-cleido-mastoideus.**
8. **Small occipital nerve.**
9. **Nervus cutaneus colli.**
10. **Branches to levator scapulæ.**

third loop by the third and fourth nerves. The *branches* of the cervical plexus may be classified as follows :—

Superficial	Ascending	Smaller occipital.
		Great auricular.
	Transverse	Nervus cutaneus colli.
	Descending	Anterior supraclavicular.
		Middle supraclavicular.
		Posterior supraclavicular.
Deep		Muscular.
		Communicating.

The *superficial branches* have been examined.

Muscular branches.—(1) The rectus capitis anterior, rectus capitis lateralis and longus capitis are supplied from the loop formed by the first and second cervical

nerves. These twigs pass medialwards to supply the muscles. (2) The sterno-cleido-mastoideus is supplied from the second cervical nerve which communicates with the accessory nerve in the muscle. (3) The levator scapulæ, scalenus medius, trapezius and longus colli are supplied from the third and fourth cervical nerves. (4) The diaphragm is supplied by the phrenic nerve which should be studied in detail.

The **Phrenic Nerve** arises chiefly from the fourth cervical nerve, but is joined also by a filament from the third and another from the fifth cervical nerve. The nerve thus formed crosses the scalenus anterior muscle obliquely from the lateral to the medial side and from above downwards to the root of the neck. In its course in the neck it is covered by the sterno-cleido-mastoideus, the inferior belly of the omohyoideus, the transverse cervical and transverse scapular vessels and the sub clavian vein. Finally it crosses the internal mammary artery to enter the thorax. Its course within the thorax has been described (p. 162).

The *communicating branches* are :—(1) The *communicantes cervicales*. These consist of two branches one from the second and the other from the third cervical nerve. These two branches unite to form the *descendens cervicalis* which descends along the lateral side of the internal jugular vein and unites with the descendens hypoglossi about the middle of the neck to form the ansa hypoglossi. (2) *Communicating branches to the accessory nerve.*—The branch from the second cervical nerve which supplies the sterno-cleido-mastoid muscle communicates with the accessory nerve in the substance of the muscle. The branches from the third and fourth cervical nerves which supply the trapezius communicate with the accessory nerve underneath the muscle. (3) *Communicating branches to the vagus and hypoglossal nerves.*—These proceed from

the loop formed by the first and second cervical nerves to the base of the skull and will be examined at a later stage of dissection. (4) *Grey rami communicantes.* These come from the superior cervical ganglion of the sympathetic trunk to each of the upper four cervical nerves.

The dissector should now proceed to examine the thyreoid gland, the cervical portions of the trachea and the œsophagus.

The **Thyreoid Gland** is a ductless gland situated at the front and sides of the neck. It consists of two lateral lobes joined across the middle line by a narrow transverse band called the *isthmus.* It is usually larger in the female than in the male. It is covered by the pretracheal layer of the fascia colli. Each lobe is conical in shape with the *apex* above at the level of the junction of the lower with the middle third of the thyreoid carti-

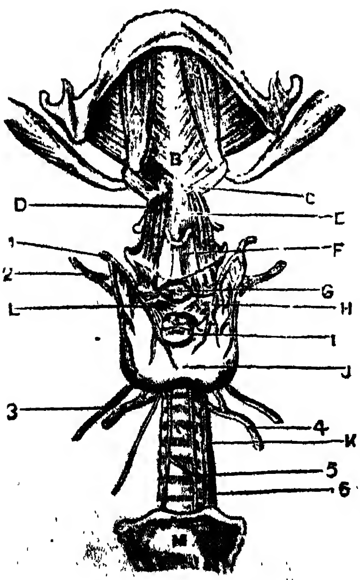


Fig. 69.—Dissection of the middle line of the neck (Cunningham).

A. Digastricus.
B. Mylo-hyoideus.
C. Hyoid bone.
D. Thyreo-hyoid muscle.
E. Hyo-thyreoid membrane.
F. Thyreoid cartilage.
G. Middle crico-thyreoid ligament.
H. Cricoid cartilage.
I. Trachea.
J. Isthmus of thyreoid gland.
K. Œsophagus.
L. Crico-thyreoid muscle.
M. Sternum.
1. Superior laryngeal artery.
2. Superior thyreoid vein.
3. Middle thyreoid vein.
4. Inferior thyreoid artery.
5. Inferior thyreoid vein.
6. Recurrent nerve.

lage. The *base* is on a level with the fifth or sixth tracheal ring. Its *lateral surface* is convex and covered by the superior belly of the omohyoid, sterno-hyoid and sterno-thyreoid muscles. Its *medial surface* is concave being moulded over the trachea, the cricoid and thyreoid cartilages. Its *posterior border* lies in contact with the œsophagus and pharynx and usually overlaps the common carotid artery. The *anterior border* is thinner than the posterior and extends along the middle line of the neck. The isthmus joins the lower parts of the anterior borders of the lobes and lies opposite the second, third and fourth rings of the trachea. From the upper part of the isthmus a third lobe, called the *pyramidal lobe*, is sometimes found projecting upwards as far as the hyoid bone. Its base is continuous with the isthmus. Its apex is attached to the hyoid bone by fibrous tissue or by a band of muscular fibres called the *levator glandulæ thyreoideæ*. The fibrous *capsule* of the thyreoid gland is derived from the fascia colli.

Blood-vessels of the thyreoid gland.—The arteries supplying the gland are the branches of the superior and inferior thyreoid arteries and occasionally the thyreoidea ima. These have been already examined. The veins are (1) the superior thyreoid vein which opens into the internal jugular; (2) the inferior thyreoid vein which joins its fellow of the opposite side to form a common trunk and ends in the left innominate vein; and (3) the middle thyreoid vein which ends in the internal jugular.

The **Parathyreoid Glands** are small oval bodies of a reddish brown colour situated at the posterior borders of the lateral lobes of the thyreoid gland. They are usually four in number, two being connected with each lateral lobe, and lie under cover of the pretracheal fascia. Of these two, one is placed at the upper part of the posterior border and the other at its lower part.

Trachea.—The thoracic portion of this tube has been described (p. 197). The *cervical portion* extends from the cricoid cartilage to the upper border of the manubrium sterni. It is covered in front by the isthmus of the thyreoid body, the inferior thyreoid veins, the thyreoidea ima artery (when present), the innominate artery at the root of the neck, the sterno-hyoid and sterno-thyreoid muscles, the pretracheal layer of fascia colli and the connecting branch between the anterior jugular veins of the two sides. Behind it rests on the œsophagus. On either side are the common carotid artery, the lateral lobe of the thyreoid gland and the recurrent nerve (lying between it and the œsophagus).

The **Œsophagus** or **Gullet** is a muscular tube extending from the lower end of the pharynx to the stomach. Its *thoracic portion* has been described (p. 199). Its *cervical portion* begins at the level of the lower border of the cricoid cartilage. At its commencement it lies in the middle line and then inclines to the left. The trachea lies in front of it, while behind it rests upon the prevertebral muscles. Laterally it is in relation with the common carotid artery and the lateral lobe of the thyreoid gland (specially on the left side).

TEMPORAL AND INFRATEMPORAL REGIONS.

The dissection of these regions comprises an examination of :—

1. The masseter, temporal, and external and internal pterygoid muscles.
2. Internal maxillary artery and its branches, pterygoid plexus of veins and internal maxillary vein.
3. Mandibular nerve and its branches.

The **Masseter** is quadrilateral in shape. It consists of two portions, superficial and deep. The *superficial*

portion arises from the lower border of the anterior two-thirds of the zygomatic arch; the *deep portion* arises from the posterior third of the lower border and the whole length of the medial surface of the zygomatic arch. The fibres of the superficial portion pass downwards and backwards and those of the deep portion pass downwards and forwards. The muscle is inserted into the lateral surface of the ramus and coronoid process of the mandible. The masseteric branch of the mandibular nerve enters the deep surface of the muscle to supply it and will be seen when the muscle is reflected.

The **Temporal Fascia** is a strong aponeurosis covering the temporal muscle. Above it is attached to the whole extent of the superior temporal line. This upper margin has been detached by the dissector when the skull cap was sawn. Below it divides into two layers which are attached to the lateral and medial lips of the upper border of the zygomatic arch. If the superficial layer of the temporal fascia is divided close to the zygomatic arch the zygomatico-temporal branch of the superficial temporal artery, the zygomatico-temporal branch of the maxillary nerve and a small quantity of fat will be seen to lie between the two layers. From the deep surface of the fascia the superficial fibres of the temporal muscle take their origin.

The temporal muscle should now be fully exposed. Divide the zygomatic arch first in front near its junction with the zygomatic bone and then behind near the external acoustic meatus and turn the arch downwards with the masseter attached to it, taking care of the masseteric vessels and nerve which cross the mandibular notch to enter the deep surface of the muscle.

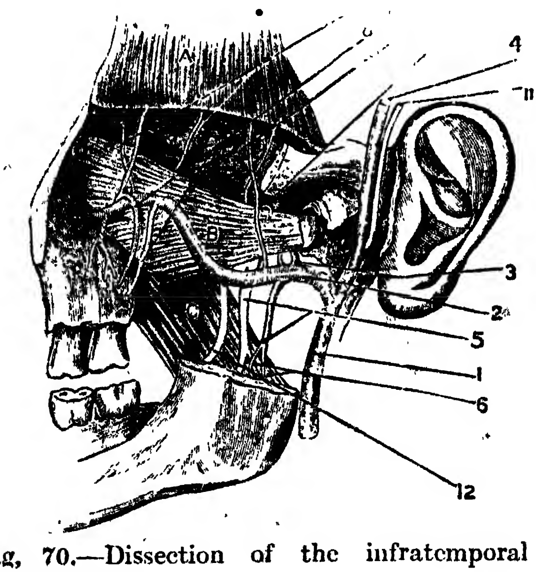
The **Temporalis** (Temporal muscle) arises from the inferior temporal line and the entire extent of the temporal fossa (except that part of it which is formed by the zygoma-

tic bone) and from the inner surface of the temporal fascia. Its fibres converge into a strong tendon which is inserted into the coronoid process and anterior border of the ramus of the mandible. It is supplied by the mandibular nerve.

Saw through the base of the coronoid process in a direction downwards and forwards from behind so that the insertion of the temporal muscle is included. Reflect it upwards with the temporal muscle, which should be detached from the lower part of the temporal fossa. Next to obtain a good view of the structures of the infratemporal fossa remove a portion of the ramus of the mandible by sawing through the neck of the bone and by another cut just above the mandibular foramen (Fig. 70). While using the saw in the latter situation protect the soft parts on the medial aspect of the ramus by a piece of cloth inserted between the soft parts and the bone and pulled down as low as the mandibular foramen through which the inferior alveolar vessels and nerves are entering. This dissection brings into view the external and internal pterygoid muscles, the former passing horizontally forwards from the neck of the mandible and the latter passing vertically downwards on the medial aspect of the external pterygoid muscle. Taking the external pterygoid muscle as guide search for the vessels and nerves in this region. Thus along the upper border of the muscle look for the masseteric nerve entering the deep surface of the masseter and the two deep temporal nerves entering the temporal muscle. Along the lower border of the muscle look for the lingual and inferior alveolar nerves. Along the lateral surface of the muscle the internal maxillary artery passes upwards and forwards while the buccinator nerve runs downwards and forwards.

The **Pterygoideus Externus** (External pterygoid muscle) arise by two heads, an upper and a lower. The

upper head arises from the infratemporal ridge and in ra-temporal surface of the great wing of the sphenoid; the *lower head* arises from the lateral surface of the lateral pterygoid amina of the sphenoid. From this ori in the muscle passes horizontally backwards to be inserted into the depression on the anterior surface of the neck of the mandible and into the anterior margin of the articular disc of the temporo-mandibular articulation. It is supplied by the mandibular nerve.



Fig, 70.—Dissection of the infratemporal region (Cunningham).

A. Temporalis.
B. Pterygoideus externus.
C. Pterygoideus internus.
1. External carotid artery.
2. Internal maxillary artery.
3. Middle meningeal artery.
4. Superficial temporal artery.
5. Inferior alveolar artery and nerve.
6. Mylo-hyoid artery and nerve.
7. Anterior deep temporal artery and nerve.
8. Buccinator artery and nerve.
9. Posterior deep temporal artery and nerve.
10. Masseteric nerve.
11. Auriculo-temporal nerve.
12. Lingual nerve.

The **Pterygoideus Internus** (Internal pterygoid muscle) arises (1) from the medial surface of the lateral pterygoid lamina, (2) from the grooved posterior surface of the pyramidal process of the palatine bone, (3) from the lateral surface of the same process, and (4) from the tuberosity of the maxilla. The muscle passes downwards, backwards and lateralwards to be inserted into the lower and back part of the medial surface of the ramus and angle of the mandible below the mandibular foramen. It is supplied by the mandibular nerve.

The **Internal Maxillary Artery** is the larger terminal branch of the external carotid artery. It arises behind the neck of the mandible in the substance of the parotid gland and is usually divided into three portions. The *first portion* (mandibular part) proceeds forwards between the neck of the mandible and the spheno-mandibular ligament being placed along the lower border of the pterygoideus externus. The *second portion* (pterygoid part) runs obliquely upwards and forwards on the superficial surface of the pterygoideus externus (sometimes on the deep surface of the muscle), being placed under cover of the temporal muscle. The *third portion* (pterygopalatine part) passes medialwards between the two heads of the pterygoideus externus to enter the pterygo-palatine fossa.

Branches.

From the 1*st part*	From the 2*nd part*	From the 3*rd part*
1. Anterior tympanic.	1. Deep temporal.	1. Posterior superoir alveolar.
2. Deep auricular.	2. Pterygoid.	2. Infraorbital.
3. Middle meningeal.	3. Masseteric.	3. Descending palatine.
4. Accessory meningeal.	4. Buccinator.	4. Artery of the pterygoid canal.
5. Inferior alveolar.		5. Pharyngeal.
		6. Sphenopalatine.

The temporo-mandibular joint should now be studied. The condyle of the mandible should then be thrown forwards which will display fully all the branches of the first part of the internal maxillary artery.

The Temporo-mandibular Joint is a ginglymus or hinge-joint. The parts entering into the formation of the joint are the articular tubercle (eminentia articularis) and the anterior portion of the glenoid fossa of the temporal bone above and the condyle of the mandible below. The following are the ligaments of the joint :—

(1) The *articular capsule* which is attached above around the mandibular fossa and to the articular tubercle, below to the neck of the mandible.

(2) The *temporo-mandibular ligament* (external ligament) is attached above to the lateral surface of the zygomatic process of the temporal bone and to the tubercle at the root of the zygoma. The igament passes downwards and backwards to be attached below to the lateral aspect of the neck of the mandible.

(3) The *spheno-mandibular ligament* extends from the spina angularis of the sphenoid above to the lingula of the mandible below. It is in reality a thickened band derived from the process of the fascia colli which passes beneath the parotid gland. The internal maxillary vessels pass between it and the neck of the mandible.

(4) The *stylo-mandibular ligament* extends from the styloid process of the temporal bone to the angle and adjoining posterior border of the ramus of the mandible. It is also a thickened band derived from the process of the fascia colli which passes beneath the parotid gland.

To expose the articular disc divide the capsule close to the temporal bone.

(5) The *articular disc* is an oval fibrocartilaginous plate interposed between the articular surfaces. Its upper surface is concave in front and convex behind to

fit respectively into the corresponding articular tubercle and glenoid fossa. Its lower surface is concave to fit into the convexity of the condyle of the mandible. Its circumference is attached to the surrounding articular capsule. Its anterior border gives attachment to the tendon of the pterygoideus externus.

Synovial stratum.—There are two synovial strata: one lining the upper surface of the disc and the part of the articular capsule above it; the other lines the lower surface of the articular disc and the part of the articular capsule below it.

Throw the condyle of the mandible forwards with the pterygoideus externus attached to it and examine the branches of the internal maxillary artery.

The *anterior tympanic artery* passes upwards behind the temporo-mandibular joint and enters the tympanic cavity through the petro-tympanic fissure (Glasserian fissure). It supplies the tympanic membrane and anastomoses with the stylomastoid artery on its surface.

The *deep auricular artery* also passes upwards behind the temporo-mandibular joint and pierces the anterior wall of the external acoustic meatus to supply the skin lining it.

The *middle meningeal artery* passes upwards along the medial surface of the external pterygoid muscle between the two roots of the auriculo-temporal nerve. It enters the cranial cavity through the foramen spinosum. Its course and branches in the cranial cavity have been examined (p 242).

The *accessory meningeal artery* arises sometimes from the middle meningeal. It enters the cranial cavity through the foramen ovale. Its distribution in the cranial cavity has been examined (p. 243).

The *inferior alveolar artery* (inferior dental artery) passes downwards and forwards accompanied by the

inferior alveolar nerve and enters the mandibular foramen of the mandible. The exit of its mental branch through the mental foramen has been seen during the dissection of the face. Before entering the mandibular foramen it gives off two branches: (1) the *lingual branch* which descends with the lingual nerve and supplies the mucous membrane of the mouth; (2) the *mylohyoid artery* which passes downwards and forwards in the mylohyoid groove with the nerve of the same name and ramifies on the superficial surface of the mylohyoid muscle.

The *deep temporal arteries* are two in number, anterior and posterior, which ascend between the pericranium and the temporal muscle. They . supply the muscle and anastomose with the middle temporal artery.

The *pterygoid branches* are given off to the external and internal pterygoid muscles.

The *masseteric artery* crosses the mandibular notch with the nerve of the same name and enters the deep surface of the masseter muscle.

The *buccinator artery* runs forwards with the buccinator nerve to the outer surface of the buccinator muscle. It supplies the muscle and anastomoses with the branches of the external maxillary artery.

The *posterior superior alveolar artery* (posterior dental artery) is the only branch of the third part of the internal maxillary artery which can be examined now. It descends upon the infratemporal surface of the maxilla and divides into many minute branches; some of which enter the alveolar canals to supply the lining of the maxillary sinus and the upper molar and premolar teeth; while others are continued to supply the gums.

The remaining branches of the third portion of the internal maxillary artery will be examined during the dissection of the pterygo-palatine fossa.

The Pterygoid Plexus of Veins and the Internal Maxillary

Vein.—Around the external pterygoid muscle is seen a plexus of veins called the pterygoid plexus into which the tributaries corresponding to the branches of the internal maxillary artery open. From this plexus proceeds a short venous trunk called the internal maxillary vein which accompanies the first portion of the internal maxillary artery. Passing through the parotid gland it unites behind the neck of the mandible with the superficial temporal vein to form the posterior facial vein (temporo-maxillary vein). The pterygoid plexus communicates above with the cavernous sinus by emissary veins which pass through the foramen ovale, the foramen Vesalii and the foramen lacerum. In front it communicates with the anterior facial vein by the *deep facial vein* which proceeds forwards beneath the masseter muscle to join the anterior facial vein. It also communicates with the inferior ophthalmic vein in the orbit by a small branch which passes through the inferior oribital fissure.

The **Mandibular Nerve** (Inferior maxillary nerve) is the largest of the three divisions of the trigeminal nerve. It differs from the other two divisions in containing both motor and sensory fibres. The motor root of the trigeminal nerve comes out of the cranial cavity in company with the third division of the semilunar ganglion through the foramen ovale. They unite with each other either inside the foramen or just after their exit from it to form the mandibular nerve. The mixed nerve trunk lies under cover of the external pterygoid muscle and immediately divides into an anterior and a posterior division. Prior to the division two branches viz., the nervus spinosus and the nerve to the pterygoideus internus are given off from the main trunk.

The *nervus spinosus* (recurrent branch) enters the cranial cavity through the foramen spinosum with the

middle meningeal artery. Its distribution has been examined (p. 244).

The *nerve to the pterygoideus internus* is a slender branch which passes forwards to enter the deep surface of the internal pterygoid muscle. It supplies the motor root to the otic ganglion.

The anterior division (nervus masticatorius) of the mandibular nerve is the smaller of the two divisions. It contains motor and sensory fibres and divides into branches which supply the muscles of mastication and the skin and mucous membrane of the cheek. It gives off the following branches :—(1) masseteric, (2) deep temporal, (3) external pterygoid and (4) buccinator.

The *masseteric nerve* passes above the pterygoideus externus and crosses the mandibular notch with the artery of the same name to enter the deep surface of the masseter.

The *deep temporal nerves* are two in number, an anterior and a posterior. They run upwards above the pterygoideus externus to enter the deep surface of the temporal muscle.

The *nerve to the pterygoideus externus* enters the deep surface of the muscle to supply it.

The *buccinator nerve* (long buccal nerve) sometimes arises in common with the preceding nerve, runs lateralwards between the two heads of the external pterygoid muscle and then downwards under cover of the temporal muscle. Emerging from beneath the anterior border of the masseter it lies on the superficial surface of the buccinator and communicates with the buccal branches of the facial nerve forming the *buccal plexus*. Filaments from the plexus supply the skin and the mucous membrane of the cheek. A *temporal branch* is given off from this nerve after its passage through the external pterygoid muscle and enters the deep surface of the temporal muscle.

The posterior division of the mandibular nerve contains mainly sensory fibres but receives some fibres from the motor root also. It divides into three branches (1) auriculotemporal, (2) lingual and (3) inferior alveolar.

The *auriculo-temporal nerve* arises by two roots between which the middle meningeal artery passes. It runs backwards under cover of the pterygoideus externus to the neck of the mandible. It then proceeds upwards in company with the superficial temporal artery between the auricula and the condyle of the mandible under cover of the parotid gland. Crossing the posterior part of the zygomatic arch it reaches the temporal region where it has been studied (p. 224). Its branches are :—(1) *communicating branches.* Two twigs from the otic ganglion join the two roots of the nerve ; the two filaments to the facial nerve pass forwards to join that nerve at the posterior border of the masseter muscle. (2) *Articular branches,* one or two twigs which enter the temporomandibular joint. (3) *Parotid branches* which supply the parotid gland. (4) *Auricular branches* which are usually four in number: two of them supply the skin of the external acoustic meatus by passing through the bony and cartilaginous portions of the canal ; the other two filaments supply the skin of the upper and front part of the auricula. (5) *Temporal branches.* These have been examined during the dissection of the scalp (p. 224).

The *lingual nerve* is purely sensory and supplies the mucous membrane and papillæ of the anterior two-thirds of the tongue. It lies under cover of the external pterygoid muscle and is joined in this situation at an acute angle by the chorda tympani nerve. Emerging from the lower border of the muscle it lies in front of and medial to the inferior alveolar nerve, runs downwards and forwards between the ramus of the mandible and the internal

pterygoid muscle and reaches the submaxillary region. Its further course will be studied later on.

The *inferior alveolar nerve* (inferior dental nerve) is the largest branch of the mandibular nerve. It is chiefly sensory but also contains some motor fibres. Emerging from the lower border of the external pterygoid muscle behind the lingual nerve, it runs downwards to enter the mandibular foramen in company with the inferior alveolar artery. The motor fibres contained in the inferior alveolar nerve leave it just before its entrance into the mandibular foramen as the mylohyoid nerve. This *mylohyoid nerve* runs along the mylohyoid groove of the mandible in the submaxillary triangle where it has been seen to supply the mylohyoid muscle and the anterior belly of the digastric. Besides the mylohyoid branch the inferior alveolar nerve gives off other branches inside the mandibular canal. To expose these branches remove the lateral wall of the mandibular canal by a chisel. The branches given off within the canal are : (1) *dental branches* which supply the molar and premolar teeth, (2) *incisive branch* which supplies the canine and incisor teeth : (3) *mental branch* which emerges through the mental foramen and communicates with the mandibular branch of the facial nerve.

The *inferior alveolar artery* in the mandibular canal is now exposed. It supplies dental branches to each of the molar and premolar teeth and divides into an incisor and a mental branch. The incisor branch supplies twigs to the canine and incisor teeth and passes forwards to the symphysis menti. The mental branch issues through the mental foramen and appears on the face where it has been examined.

Chorda Tympani Nerve.—A portion of this nerve in the infratemporal region is now seen. It issues out of the petrous portion of the temporal bone through a slit at the medial end of the petro-tympanic fissure (canal

of Huguier). It is joined by a filament from the otic ganglion and runs downwards and forwards under cover of the external pterygoid muscle to join the lingual nerve at an acute angle.

DEEP DISSECTION OF THE SUBMAXILLARY REGION.

The superficial dissection of the submaxillary triangle has been finished (p. 320). For the deep dissection of this region the student should proceed to expose fully the mylohyoid muscle by reflecting the anterior belly of the digastric muscle from the mandible and hooking the submaxillary gland backwards. The *submaxillary lymph glands*, usually four to six in number, which lie on the surface of the submaxillary gland are to be removed. Clear the surface of the mylohyoid by removing the cervical portion of the external maxillary artery and the anterior facial vein. Note the mylohyoid nerve on the surface of the mylohyoid muscle and supplying it and the anterior belly of the digastric.

The **Mylohyoid Muscle** arises from the mylohyoid line of the mandible. The posterior fibres are inserted into the anterior surface of the body of the hyoid bone. The anterior fibres pass downwards, forwards and medialwards to be inserted into a fibrous raphe extending from the symphysis menti to the body of the hyoid bone. The muscles of both sides together form what is called the *diaphragm of the mouth*. It is supplied by the mylohyoid branch of the inferior alveolar nerve which runs along its surface.

Divide the mylohyoid muscle near its attachment to the mylohyoid line, taking care that the mucous membrane of the mouth is not injured and separate the muscle from its fellow of the opposite side by a vertical cut through

the median raphe. Reflect the muscle downwards. Next saw through the mandible a little lateral to the symphysis menti and hook the loose portion of the mandible upwards. This dissection brings into view the *parts covered by the mylohyoid muscle*, viz., the submaxillary (deep portion) and sublingual glands with their ducts, the stylohyoid ligament, the hyoglossus, styloglossus, geniohyoid and genioglossus muscles, the lingual artery and vein, the lingual, hypoglossal and glossopharyngeal nerves, and the submaxillary ganglion.

The Submaxillary Gland consists of two portions, a superficial and a deep. The *superficial portion* lies against a fossa on the inner surface of the body of th mandible. The anterior belly of the digastric muscle lies in front of it, and the stylomandibular ligament separates it from the parotid gland behind. The external maxillary artery lies embedded in a groove at its posterior part. It is covered by the skin, superficial fascia, platysma and deep fascia and rests upon the under surface of the mylohyoid muscle. The *deep portion* of the gland is prolonged forwards above the posterior border of the mylohyoid muscle and lies on the under surface of the hyoglossus muscle. Above it is the lingual nerve with the submaxillary ganglion and below it is the hypoglossal nerve with its vena comitans.

The *submaxillary duct* (Wharton's duct) is about two inches in length and arises from the deep portion of the gland. It proceeds forwards along he inferior surface of the hyoglossus muscle, the lingual nerve lying above and the hypoglossal nerve below it. Then it is crossed by the lingual nerve on the surface of the genioglossus muscle. Finally it passes between the last named muscle and the sublingual gland and opens on the summit of a papilla close to the frenulum linguæ.

The Sublingual Gland is shaped like an almond and

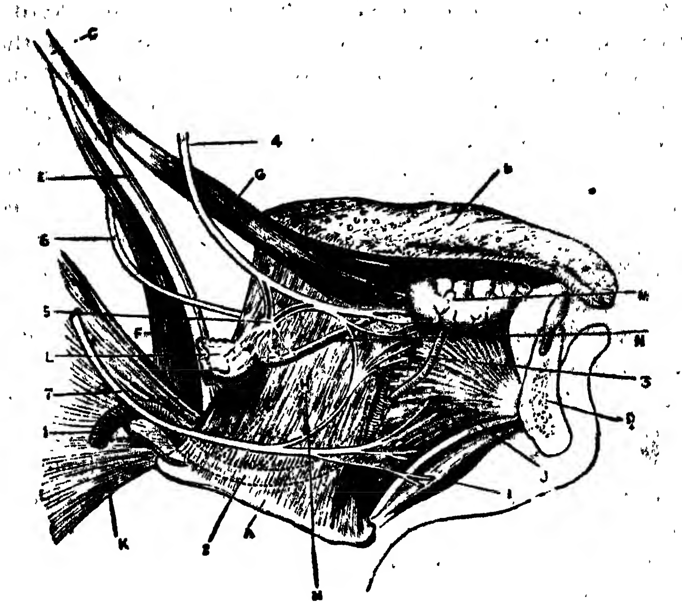


Fig. 71.—Dissection of the submaxillary region (Cunningham).

A. Hyoid bone.
B. Tongue.
C. Styloid process.
D. Symphysis menti.
E. Stylo-hyoid ligament.
F. Stylo-pharyngeus.
G. Stylo-glossus.
H. Hyo-glossus.
I. Genio-hyoid.
J. Genio-glossus.
K. Middle constrictor of pharynx.
L. Deep portion of submaxillary gland.
M. Sublingual gland.
N. Submaxillary duct.
1. Lingual artery.
2. The same, under cover of the hyo-glossus.
3. Sublingual artery.
4. Lingual nerve.
5. Submaxillary ganglion.
6. Glosso-pharyngeal nerve.
7. Hypoglossal nerve.

is the smallest of the salivary glands. It lies below the raised fold of the mucous membrane of the floor of the mouth, called the *plica sublingualis*. Below it rests on the upper surface of the mylohyoid muscle. Laterally

it lies against a fossa on the inner surface of the body of the mandible close to the symphysis menti. Medially it is in relation with the genioglossus muscle ; the lingual nerve and the submaxillary duct separate it from the muscle. Behind it is in relation with the deep portion of the submaxillary gland. Its *ducts* (ducts of Rivini) are eight to ten in number. Some of them open into the submaxillary duct ; others open into the floor of the mouth on the plica sublingualis.

The **Hyoglossus** is a quadrilateral muscle which arises from the anterior surface of the body of the hyoid bone and from the whole length of its greater cornu. Its fibres proceed upwards to be inserted into the side of the tongue medial to the insertion of the styloglossus with which its fibres decussate. It is supplied by the hypoglossal nerve.

The **Styloglossus** arises from the anterior aspect of the terminal part of the styloid process and the upper part of the stylohyoid ligament. It is inserted into the side of the tongue as far forwards as its tip. It is supplied by the hypoglossal nerve.

The **Geniohyoideus** arises from the inferior mental spine on the inner aspect of the symphysis menti and is inserted into the body of the hyoid bone just above the insertion of the mylohyoid muscle. It is supplied by the hypoglossal nerve.

The **Genioglossus** is a fan-shaped muscle which arises from the superior mental spine behind the symphysis of the mandible. It is inserted (1) into the under surface of the tongue close to the middle line extending from the tip to the base of the organ, (2) into the body of the hyoid bone above the insertion of the geniohyoid, and (3) into the wall of the pharynx blending with its middle constrictor muscle. It is supplied by the hypoglossal nerve.

The **Lingual Nerve** has been traced to the point where it lies between the internal pterygoid muscle and the ramus of the mandible (p. 353). It then proceeds forwards to the side of the tongue across the styloglossus and the hyoglossus and above the deep portion of the submaxillary gland. Further forwards it crosses the submaxillary duct and reaches the tip of the tongue being covered only by the mucous membrane. It gives off *communicating branches* to the submaxillary ganglion and to the hypoglossal nerve. The latter form two or three loops at the anterior border of the hyoglossus. The *branches of distribution* supply the mucous membrane of the mouth, the gums and the sublingual gland; some branches go to supply the mucous membrane and the papillæ over the ant.rior two-thirds of the tongue by piercing the substance of the organ.

The **Submaxillary Ganglion** is a very small ganglion placed upon the hyoglossus muscle between the lingual nerve and the deep portion of the submaxillary gland. It is connected with the lingual nerve by two roots of which the posterior one carries to the ganglion secretory fibres (*motor*) from the chorda tympani branch of the facial nerve and *sensory* fibres from the lingual proper. The anterior root carries fibres from the ganglion to the lingual nerve for distribution to the sublingual gland. The *sympathetic* root of the ganglion is derived from the plexus around the external maxillary artery. From the gan lion branches are supplied to the submaxillary gland and its duct and to the mucous membrane of the mouth.

Hypoglossal Nerve. In the present stage of the dissection the nerve is seen to run forwards on the surface of the hyoglossus. It is then continued in the substance of the genioglossus as far as the tip of the tongue. In this situation it gives off branches to the styloglossus, hyo-

glossus, geniohyoid ; genioglossus and the intrinsic muscles of the tongue. At the anterior border of the hyoglossus it communicates with the lingual nerve forming two or three loops. A vein, called the *vena comitans hypoglossi*, accompanies the hypoglossal nerve. It begins at the tip of the tongue and opens into the common facial vein or sometimes into the lingual veins.

Reflect the hyoglossus muscle upwards by dividing its attachment to the hyoid bone. The second part of the lingual artery is exposed.

Lingual Artery. -The *first part* of the artery and the hyoid branch given off from it has been studied. The *second part* of the artery is placed upon the middle constrictor of the pharynx and under cover of the hyoglossus and runs along the upper border of the greater cornu of the hyoid bone. Reaching the anterior border of the hyoglossus it ascends to the under surface of the tongue between the genioglossus and hyoglossus muscles. This constitutes the *third part* of the artery. The *fourth part* of the artery is its continuation forwards to the tip of the tongue along the lateral side of the genioglossus. This fourth portion is known as the arteria profunda linguæ. The branches given off from the second and third parts of the lingual artery are : (1) *Rami dorsalis linguæ*. These are two or three small branches which arise from the second part of the artery and ascend under cover of the hyoglossus to the back part of the dorsum of the tongue to supply its mucous membrane, the palatine tonsil and the soft palate. (2) The *sublingual artery* which arises from the second part of the lingual near its termination under cover of the anterio border of the hyoglossus. It passes forwards and upwards upon the genioglossus which it supplies and ends in the sublingual gland. It sends a twig to anastomose with the artery of the opposite side and also with the submental branch

of the external maxillary artery. (3) The *arteria profunda linguæ* (ranine artery) is the fourth or terminal portion of the lingual artery. It passes to the tip of the tongue with a tortuous course along with the lingual nerve.

The *lingual veins* are the venæ comitantes of the lingual artery. They terminate in the internal jugular vein.

The *stylohyoid ligament* extends from the tip of the styloid process to the lesser cornu of the hyoid bone. It may contain a piece of cartilage or may be partially ossified.

The **Glossopharyngeal Nerve** is seen in the present stage of dissection to emerge from beneath the stylopharyngeus muscle. Winding round that muscle it curves forwards and passes under cover of the hyoglossus to be distributed to the mucous membrane of the fauces, the sides and dorsum of the tongue and the palatine tonsil.

DEEP DISSECTION OF THE NECK.

In this dissection the student has to examine :—

(1) The stylopharyngeus and rectus capitis lateralis muscles.

(2) The internal carotid and ascending pharyngeal arteries ; the ascending palatine and tonsillar branches of the external maxillary artery and the internal jugular vein.

(3) The cervical portion of the sympathetic trunk ; the glossopharyngeal, vagus, accessory and hypoglossal nerves and the first cervical nerve.

Divide the posterior belly of the digastric and the stylohyoid muscle near their origin and reflect them forwards noting the nerve twigs supplying them. Divide the posterior and terminal branches of the external carotid

artery and reflect it forwards. Clean the stylopharyngeus muscle.

The **Stylopharyngeus** arises rom the medial aspect of the root of the styloid process of the temporal bone and passes downwards and forwards to the side of the pharynx. Its fibres pass between the superior and middle constrictor muscles of the pharynx: some are lost in those muscles; others are inserted into the posterior border of the corresponding lamina of the thyreoid cartilage. It is supplied by a twig from the glossopharyngeal nerve.

Cut through the base of the styloid process and throw it forwards with the muscles attached.

Internal Carotid Artery.—This vessel commences at the bifurcation of the common carotid and runs almost vertically upwards to enter the carotid canal in the petrous portion of the temporal bone. The portion that lies in the neck is called the first or *cervical portion.* It has *in front* the skin, superficial fascia, the platysma, the sterno-cleido-mastoideus, the parotid gland, the stylopharyngeus, the stylohyoideus and the posterior belly of the digastricus. It is crossed by the hypoglossal and glossopharyngeal nerves, the occipital and posterior auricular arteries. *Behind* it lies against the longus capitis and the sympathetic trunk. On its *lateral side* is the internal jugular vein separated from it near the base of the skull by the glossopharyngeal, vagus, accessory and hypoglossal nerves. On its *medial side* are the pharynx, the palatine tonsil and the ascending pharyngeal artery. No branches are given off from the cervical portion of this artery.

The **Ascending Pharyngeal Artery** is a slender vessel which taking origin from the external carotid near its commencement runs vertically upwards between the internal carotid artery and the wall of the pharynx.

Reaching the base of the skull it divides into meningeal branches. It gives off :—(1) *prevertebral branches* which supply the prevertebral muscles and anastomose with the ascending cervical artery; (2) *pharyngeal branches* which supply the constrictor muscles of the pharynx; one of these enters the pharynx above the superior constrictor muscle to supply the soft palate and the palatine tonsil; (3) *meningeal branches* which enter the cranial cavity through apertures at the base of the skull, viz., the jugular foramen, the foramen lacerum and the hypoglossal canal and supply the duramater.

The *ascending palatine artery* arises from the external maxillary artery near its commencement. It ascends between the styloglossus and stylopharyngeus muscles and along the lateral wall of the pharynx to the base of the skull. It gives off two branches; one of which pierces the superior constrictor of the pharynx and the other enters the pharynx along the upper border of the muscle to supply the soft palate and palatine tonsil.

The *tonsillar branch* of the external maxillary artery ascends along the lateral wall of the pharynx and pierces the superior constrictor muscle to supply the palatine tonsil.

The **Internal Jugular Vein** is the continuation of the transverse sinus, which leaves the cranial cavity through the posterior compartment of the jugular foramen. At its commencement it is joined by the inferior petrosal sinus outside the jugular foramen. Here it presents a dilatation called the *superior bulb*. At first it lies upon the rectus capitis lateralis and behind the internal carotid artery; the lower four cerebral nerves intervening between the artery and the vein. Then it descends on the lateral side of the artery up to the upper border of the thyreoid cartilage. Below that it lies to the lateral side of the common carotid artery. Throughout its whole course

in the neck it is contained within the carotid sheath with the vagus nerve. Finally it unites with the subclavian vein to form the innominate vein behind the medial end of the clavicle. Before its termination it presents another dilatation called the *inferior bulb*. A pair of valves will be seen inside the vessel about an inch above its termination. Many lymph glands are found both in front of and behind the vein. These are the *superior deep cervical lymph glands*.

Tributaries.—The internal jugular vein receives (1) the inferior petrosal sinus, (2) the common facial, and (3) lingual veins, (4) the vena comitans n. hypoglossi, (5) the pharyngeal, (6) the superior and middle thyreoid veins and (7) sometimes the occipital vein. The thoracic duct opens into the left internal jugular vein at its union with the left subclavian vein and the right lymphatic duct into the right internal jugular vein at its union with the right subclavian vein.

The **Cervical Portion of the Sympathetic Trunk** consists of three ganglia linked together by intervening nerve cords and situated behind the carotid sheath. The ganglia are named superior, middle and inferior according to their situation.

The **Superior Cervical Ganglion** lies behind the internal carotid artery and in front of the longus capitis opposite the second and third cervical vertebræ. It is fusiform in shape and about an inch in length. It communicates with (1) the upper four cervical nerves by grey rami communicantes. Hence it may be regarded as formed by the fusion of four ganglia corresponding to these four cervical nerves. It also communicates with (2) the petrous ganglion of the glosso-pharyngeal nerve, (3) the jugular ganglion and ganglion nodosum of the vagus nerve, and (4) the hypoglossal nerve. Its branches of distribution are :—(1) The *internal carotid nerve* which arises from the

upper part of the ganglion and accompanies the internal carotid artery to the carotid canal. (2) The *external carotid branches* which are several filaments surrounding the external carotid artery and forming a plexus. From the plexus offsets are prolonged on the branches of the external carotid artery. (3) The *laryngo-pharyngeal branches* pass to the lateral wall of the pharynx and communicate with the pharyngeal branches of the glosso-pharyngeal and vagus nerves forming the pharyngeal plexus. Some filaments join the superior laryngeal branch of the vagus. (4) The *superior cardiac nerve* arises from the superior cervical ganglion by two or more roots. It passes down the neck behind the common carotid artery and on the right side enters the thorax either in front of or behind the right subclavian artery and terminates in the deep cardiac plexus. The left nerve, in the thorax, joins the superficial cardiac plexus. In the neck the superior cardiac nerve is joined by other filaments from (1) the sympathetic, (2) the external laryngeal, (3) the vagus, and (4) the recurrent nerve.

The **Middle Cervical Ganglion** lies very close to the inferior thyreoid artery opposite the sixth cervical vertebra. It gives off grey rami communicantes to the fifth and sixth cervical nerves. Hence it may be regarded as formed by the fusion of two ganglia corresponding to those two nerves. It gives off (1) *thyreoid branches* which accompany the inferior thyreoid artery to the thyreoid gland and communicate with the external laryngeal and recurrent nerves. (2) The *middle cardiac nerve* which passes into the thorax either in front of or behind the right subclavian artery on the right side and on the left side between the left common carotid and subclavian arteries. It terminates in the deep cardiac plexus.

Inferior Cervical Ganglion.—To display this ganglion

the subclavian artery is to be divided at the medial border of the scalenus anterior and hooked medially. It lies between the transverse process of the seventh cervical vertebra and the neck of the first rib behind the vertebral artery. It may be fused with the first thoracic ganglion. It gives off (1) *communicating branches* (grey rami communicantes) to the seventh and eighth cervical nerves. Hence it may be regarded as formed by the fusion of two ganglia corresponding to those two nerves. (2) *Vascular branches* which surround the subclavian artery to form a plexus around it and its branches. (3) The *inferior cardiac nerve* which joins the deep cardiac plexus. This ganglion is connected with the middle cervical ganglion by two or more filaments. One of these filaments passes in front of the subclavian artery and loops round it. This loop is called the *ansa subclavia* (ansa Vieussenii).

Remove with a chisel, or with a scalpal (if the bone has been softened in weak acid solution) the ring of bone which forms the medial boundary of the jugular foramen.

The **Glossopharyngeal Nerve** leaves the skull through the central part of the jugular foramen and proceeds forwards between the internal jugular vein and the internal carotid artery. It then proceeds medialwards and crosses the latter vessel superficially. Thence it passes beneath the styloid process and the stylopharyngeus and winds round that muscle. Its further course has been described (p. 361).

While passing through the jugular foramen two ganglia are noticed in connection with this nerve, viz., an upper called the *superior ganglion* (jugular ganglion) and a lower called the *petrous ganglion.* From the petrous ganglion branches of communication are given off (1) to the superior cervical ganglion of the sympathetic, (2) to the jugular ganglion of the vagus, and (3) to the auricular

branch of the vagus. (4) Another communicating branch is given off from the glossopharyngeal nerve below the petrous ganglion which pierces the posterior belly of the digastric to join the facial nerve after its exit from the cranial cavity. The branches of distribution of the glossopharyngeal nerve are :—(1) tympanic, (2) pharyngeal, (3) nerve to the stylopharyngeus, (4) tonsillar, and (5) lingual.

To trace the course of the tympanic nerve and other nerves which pass through the petrous portion of the temporal bone, a separate piece of the petrous bone with the nerves attached to it should be taken and immersed at first in spirit to harden the nerves and then in weak acid solution to soften the bony tissue.

The *tympanic nerve* (Jacobson's nerve) arises from the petrous ganglion and reaches the tympanic cavity through a bony canal which is situated in the ridge separating the jugular fossa from the carotid canal on the inferior surface of the petrous bone. Reaching the tympanic cavity it traverses its medial wall and lies in a groove on the surface of the promontory. Then it leaves the tympanic cavity at its anterior part and passes through a bony canal to enter the middle cranial fossa through a slit just lateral to the hiatus canalis facialis on the anterior surface of the petrous portion of the temporal bone. In this bony canal it is joined by a filament from the geniculate ganglion of the facial nerve and is then termed the *lesser superficial petrosal nerve*. Its exit from the middle cranial fossa through the foramen ovale or through a slit between the sphenoid and the petrous bone has been seen (p. 244). After its exit from the cranial cavity it ultimately ends in the otic ganglion which will be seen later on. In the tympanic cavity the tympanic nerve supplies the mucous membrane of the tympanum and of the auditory tube and the lining membrane of the mastoid

cells. It also gives off the superior and inferior caroticotympanic branches which pass through the bony wall of the carotid canal to join the sympathetic plexus around the internal carotid artery.

The *pharyngeal branches* are three or four filaments which unite with the pharyngeal branches of the vagus and with the laryngo-pharyngeal branches of the sympathetic trunk to form the *pharyngeal plexus*. Filaments from this plexus supply the muscles of the pharynx and its mucous membrane.

The *nerve to the stylopharyngeus* has been already seen.

The *tonsillar branches* supply the palatine tonsil, the soft palate and the fauces.

The *lingual branches* supply the mucous membrane of the posterior third of the tongue and he anterior surface of the epiglottis.

The **Vagus Nerve** leaves the skull through the middle compartment of the jugular foramen. In the foramen it is contained in the same sheath of dura mater with the accessory nerve and separated from the glossopharyngeal which is enclosed in a separate sheath and lies in front. After its exit from the foramen the vagus nerve descends vertically within the carotid sheath and lies between the internal carotid artery and the internal jugular vein in the upper part of the neck; and between the common carotid artery and the same vein in the lower part. Within the carotid sheath it lies on a plane posterior to the artery and the vein. Finally it enters the thorax on the right side by crossing the first part of the subclavian artery and on the left side by passing between the left common carotid and left subclavian arteries.

Two ganglia are seen in connection with the vagus nerve, viz., an upper or jugular ganglion (ganglion of the root) and a lower or ganglion nodosum (ganglion of the trunk).

The *jugular ganglion* is placed in the jugular foramen. It gives off twigs which communicate with (1) the petrous ganglion of the glossopharyngeal nerve, (2) the accessory nerve, and (3) the superior cervical ganglion of the sympathetic. Two branches of distribution arise from the jugular ganglion, viz., the meningeal branch and the auricular nerve. The *meningeal branch* passes upwards through the jugular foramen to supply the dura mater. The auricular nerve (Arnold's nerve) is joined by a filament from the petrous ganglion of the glossopharyngeal nerve and passes backwards along the lateral surface of the internal jugular vein to enter the mastoid canaliculus on the lateral wall of the jugular fossa. Then it passes through the substance of the petrous portion of the temporal bone and crosses the facial canal above the stylomastoid foramen where it gives off a twig to communicate with the facial nerve. It then reaches the surface of the skull by coming out through the tympanomastoid fissure between the mastoid process and the external acoustic meatus and divides into two branches; one of which communicates with the posterior auricular branch of the facial nerve and the other supplies the posterior aspect of the ear and the external acoustic meatus.

The *ganglion nodosum* is a cylindrical swelling about three-fourths of an inch in length, developed upon the vagus nerve below the base of the skull. The cerebral portion of the accessory nerve joins it and *branches of communication* are given off from it to (1) the superior cervical ganglion of the sympathetic, (2) the loop between the first and second cervical nerves and (3) the hypoglossal nerve. The *branches of distribution* given off from the ganglion nodosum are two in number, the pharyngeal branch and the superior laryngeal nerve. The *pharyngeal branch* passes downwards and forwards crossing the internal carotid artery and enters into the formation of the

pharyngeal plexus. This plexus is formed by the communication of the pharyngeal branches of the glossopharyngeal, the vagus and the superior cervical ganglion of the sympathetic and supplies the muscles and mucous membrane of the pharynx.

The *superior laryngeal nerve* after its origin from the ganglion nodosum passes medialwards behind the internal carotid artery and divides into the external and internal laryngeal nerves. The *external laryngeal nerve* passes downwards beneath the sternothyreoid muscle and supplies the cricothyreoideus and the inferior constrictor of the pharynx. The *internal laryngeal nerve* pierces the thyreohyoid membrane in company with the superior laryngeal artery to supply the mucous membrane of the larynx. It supplies a fine twig to the superior cardiac branch of the sympathetic.

The branches given off from the trunk of the vagus nerve in the neck are the recurrent nerve (on the right side only) and the superior cardiac nerves.

The *recurrent nerve* (recurrent laryngeal nerve) on the right side arises from the vagus as it crosses the first part of the subclavian artery. It then passes upwards and medialwards behind the artery by hooking round its lower border. Reaching the side of the trachea it proceeds along the groove between it and the œsophagus to the lower border of the inferior constrictor of the pharynx. The origin of the recurrent nerve on the left side below the arch of the aorta and its course inside the thorax have been examined (p. 204). In the neck it ascends along the groove between the trachea and the œsophagus like the right recurrent nerve. Both the nerves enter the larynx under cover of the lower border of the inferior constrictor of the pharynx to supply all the intrinsic muscles of the larynx except the cricothyreoideus. The branches given off from the recurrent nerve are some cardiac

branches to the deep cardiac plexus and twigs to the trachea, œsophagus and the inferior constrictor of the pharynx.

The *superior cardiac branches* of the vagus are two in number, an upper and a lower, on each side. On the right side both the upper and lower branches enter the thorax to join the deep cardiac plexus. On the left side the upper one joins the deep cardiac plexus and the lower one, the superficial cardiac plexus.

The **Accessory Nerve** (Spinal accessory nerve) consists of two portions, a cerebral and a spinal. In the jugular foramen the cerebral portion unites with the spinal portion and is connected with the jugular ganglion of the vagus by one or two filaments. After its exit from the jugular foramen the cerebral portion leaves the accessory nerve to join the ganglion nodosum of the vagus. The accessory nerve (consisting of the spinal portion only) then passes backwards and downwards usually in front of the internal jugular vein, pierces the sterno-cleido-mastoideus at its upper part and supplies it. Its further course in the posterior triangle of the neck and its termination in the trapezius have been described (p. 294).

Hypoglossal Nerve.—The roots of the hypoglossal nerve after piercing the dura mater opposite the hypoglossal canal in two bundles unite to from a single trunk inside the canal. After its exit from the canal it is very deeply placed under cover of the internal jugular vein and the internal carotid artery. It then passes downwards and forwards behind the ganglion nodosum of the vagus with which it is closely connected. Then it proceeds between the internal jugular vein and the internal carotid artery till it reaches the lower border of the posterior belly of the digastric, and winding round the occipital artery, turns transversely forwards to cross the first part of the lingual artery. Its subsequent course has been described (p. 359).

It gives off *communicating branches* to (1) the superior cervical ganglion of the sympathetic, (2) the ganglion nodosum of the vagus (sometimes this communication is so intimate that it appears as if the two nerves are united into one mass, (3) the first cervical nerve, (4) the pharyngeal plexus (while it hooks round the occipital artery), and (5) the lingual nerve (near the anterior border of the hyoglossus). The *branches of distribution* are (1) meningeal, (2) descendens hypoglossi, (3) thyreohyoid and (4) muscular. The *meningeal branches* are given off in the hypoglossal canal to supply the dura mater in the posterior fossa of the skull. The *descendens hypoglossi* has been examined (p. 322). The *thyreohyoid branch* is a long slender twig which arises from the hypoglossal nerve near the hyoid bone and supplies the thyreohyoid muscle. The *muscular branches* supply the extrinsic and intrinsic muscles of the tongue.

The **Rectus Capitis Lateralis** arises from the upper surface of the tip of the transverse process of the atlas and is inserted into the undersurface of the jugular process of the occipital bone. It is supplied by a branch from the anterior division of the first cervical nerve.

Divide the rectus capitis lateralis at its attachment to the transverse process of the atlas and reflect it upwards. The anterior division of the first cervical nerve will be seen to form a loop with the second cervical nerve.

Suboccipital Nerve. The anterior division of the first cervical or suboccipital nerve passes forwards under cover of the vertebral artery and round the lateral surface of the superior articular process of the atlas. It appears in front at the medial side of the rectus capitis lateralis and descends in front of the transverse process of the atlas to form a loop with the ascending branch of the second cervical nerve. It supplies a twig to the rectus capitis lateralis and from the loop between it and the second

cervical nerve branches are given off to the rectus capitis anterior and longus capitis. It is also connected by communicating filaments with the vagus and hypoglossal nerves and with the superior cervical ganglion of the sympathetic.

THE PREVERTEBRAL REGION.

This dissection comprises an examination of (1) the muscles found in front of the vertebræ, viz., the longus colli and capitis and the rectus capitis anterior: (2) the vertebral artery with its companion vein. The prevertebral layer of the deep fascia of the neck can be fully examined now. An opportunity may be taken to examine the intertransverse muscles (p. 261) and the anterior and posterior divisions of the cervical nerves.

Divide the common carotid artery, the internal jugular vein, and the vagus and the sympathetic trunk near the first rib and reflect them all upwards.

The *prevertebral fascia* is a process of the deep fascia of the neck given off from the layer which lines the deep surface of the sterno-cleido-mastoideus. It has been already noted that the prevertebral layer assists in forming the posterior wall of the carotid sheath. It covers the prevertebral muscles and is continuous medially with the fascia of the opposite side behind the pharynx and the œsophagus. Above it is attached to the base of the skull and below is prolonged into the thorax in front of the longus colli. From the anterior aspect of this fascia another thin lamina is given off which passes medial to the carotid sheath to the surface of the constrictor muscles of the pharynx. This thin lamina is called the *buccopharyngeal fascia.* Thus a space is formed between the buccopharyngeal fascia in front and the prevertebral

fascia behind which is filled with areolar tissue. This space is called the *retropharyngeal space* and is continuous below with the posterior mediastinum of the thorax, but limited above at the base of the skull. The prevertebral fascia is prolonged downwards and lateralwards over the scalene muscles into the posterior triangle of the neck, where it has been found to cover the brachial plexus and the subclavian vessels.

Divide the trachea and the œsophagus near the first rib and draw them forwards till the pharynx is separated from the front of the cervical portion of the vertebral column as high as the base of the skull. Next saw through the skull obliquely downwards and forwards close behind the mastoid process until the jugular foramen is reached. The whole breadth of the basilar process extending from one jugular foramen to the other and in front of the hypoglossal canal should then be divided by means of a chisel so that the cutting edge of the chisel appears at the interval between the prevertebral muscles behind and the pharynx in front. Finally the same saw cut is to be made on the other side of the skull to the back part of the jugular foramen. The base of the skull is now divided into two portions an anterior and a posterior. The anterior part of the skull has the pharynx attached to it and should be wrapped up with cloth and kept soaked in lotion for examination later on. The posterior part of the skull with the cervical portion of the vertebral column and the prevertebral muscles should now be examined.

The **Longus Colli** extends from the third thoracic vertebra to the atlas and consists of three portions—a vertical portion, an upper oblique portion, and a lower oblique portion. The *vertical portion*, the largest of the three, arises from the ides of the first three thoracic and last two cervical vertebræ and is inserted into the bodies of the second, third and fourth cervical vertebræ.

The *upper oblique portion* arises from the anterior tubercles of the transverse processes of the third, fourth and fifth cervical vertebræ and is inserted into the tubercle on the anterior arch of the atlas. The *lower oblique portion* arises from the sides of the bodies of the upper two or three thoracic vertebræ and is inserted into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. The longus colli is supplied by branches from the anterior divisions of the cervical nerves.

The **Longus Capitis** (Rectus capitis anticus major) arises by tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ and is inserted into the inferior surface of the basilar portion of the occipital bone in front of the foramen magnum. It is supplied by branches from the anterior divisions of the first, second and third cervical nerves.

The **Rectus Capitis Anterior** (Rectus capitis anticus minor) lies beneath the preceding muscle and arises fron the anterior surface of the root of the transverse process of the atlas. It is inserted into the basilar part of the occipital bone behind the insertion of the longus capitis. It is supplied by a twig from the loop between the first and second cervical nerves.

The **Vertebral Artery** is usually divided into four parts. The *first part* extends from its origin from the subclavian artery to the point where it enters the foramen in the transverse process of the sixth cervical vertebra. This part of the vessel has been traced. The artery then ascends through the foramina of the transverse processes of the remaining upper cervical vertebræ constituting its *second part.* The *third part* begins from its exit from the foramen transversarium of the atlas and passes at first backwards and then medialwards around the lateral and posterior aspects of its superior articular

process to the groove on the lateral part of the posterior arch of the atlas. This part of the vessel has been examined during the dissection of the suboccipital triangle. The *fourth part* runs upwards and, piercing the dura mater, enters the cranial cavity through the foramen magnum and unites with the artery of the opposite side at the lower border of the pons. The dissector should remember that the vertebral artery has been divided at the lower border of the foramen magnum during the removal of the brain. The union of the two vessels at the lower border of the pons will be noted when the brain will be studied. While passing through the foramina in the transverse processes of the upper six cervical vertebræ it is surrounded by a plexus derived from the sympathetic trunk and by the vertebral plexus of veins. The *branches* given off in the neck are: (1) *muscular branches* which supply the neighbouring muscles; and (2) *spinal branches* which enter the vertebral canal through the intervertebral foramina.

The **Vertebral Vein** is formed in the suboccipital region from several small veins both inside and outside the vertebral canal. It enters the foramen in the transverse process of the atlas, proceeds downwards through the foramina transversaria forming a plexus around the vertebral artery. This plexus terminates in a single vein which emerges from the transverse process of the sixth cervical vertebra. Its subsequent course and termination in the innominate vein have been noted.

The **Intertransversarii** extend between the transverse processes of the cervical vertebræ. The *anterior intertransverse* muscles pass between the anterior tubercles of two contiguous vertebræ and the *posterior* between the posterior tubercles.

Cervical Nerves.—The anterior divisions of these nerves lie between the anterior and posterior intertransverse muscles. The posterior divisions pass behind the

posterior intertransverse muscles.

ARTICULATIONS OF THE NECK.

Cranio-vertebral Articulations.—These consist of (I) articulation between the occipital bone and the atlas and (II) articulation between the occipital bone and the epistropheus.

(I) The *articulation between the occipital bone and the atlas* constitutes a pair of condyloid joints the condyles of the occipital bone articulating with the superior articular processes of the atlas. The following are the ligaments :—(1) The *articular capsules* which are loose and are attached to the margins of the condyles of the occipital bone and the superior articular processes of the atlas. Each is lined by a synovial stratum. (2) The *anterior atlanto-occipital membrane* which extends from the anterior margin of the foramen magnum to the upper margin of the anterior arch of the atlas. It is continuous laterally with the articular capsules and is strengthened in front in the middle line by the continuation upwards of the anterior longitudinal ligament. It extends between the tubercle in front of the anterior arch of the atlas and the basilar portion of the occipital bone. (3) The *posterior atlanto-occipital membrane* which extends from the posterior margin of the foramen magnum to the upper margin of the posterior arch of the atlas. Behind the superior articular processes of the atlas it is deficient where an aperture exists for the entrance of the vertebral artery and the exit of the suboccipital nerve.

(II) *Articulation between the occipital bone and the epistropheus.*—The ligaments connecting these two bones are : (1) The membrana tectoria, (2) the two alar ligaments and (3) ligamentum apicis dentis.

The *membrana tectoria* (occipito-axial ligament) is

Fig. 72.—Dissection from behind of the ligaments connecting the occipital bone, the atlas and the epistropheus with each other (Cunningham).

1. Membrana tectoria.
2. Occipital bone.
3. Ligamentum apicis dentis.
4. Alar ligament.
5. Crus superius.
6. Crus inferius.
7. Transverse ligament.
8. Accessory atlanto-epistropheal. ligament.
9. Lateral mass of atlas.
10. Atlanto-epistropheal joint.
11. Body of epistropheus.

contained inside the vertebral canal and may be regarded as the continuation upwards of the posterior longitudinal ligament of the vertebral column to the occipital bone. To fully expose this membrane the posterior arch of the atlas and the vertebral arch of the epistropheus should be divided behind the articular processes and hooked upwards. It is attached below by its narrow end to the posterior surface of the body of the epistropheus and above by its broad end to the groove on the basilar part of the occipital bone in front of the foramen magnum.

Reflect the membrana tectoria upwards by dividing

it at its attachemnt to the epistropheus. The transverse ligament which binds the dens to the anterior arch of the atlas together with its upper and lower vertical limbs are now exposed. Divide the upper vertical limb which extends from the transverse ligament to the anterior margin of the foramen magnum. The ligamentum apicis dentis and the alar ligaments are now exposed.

The *alar ligaments* (check ligaments) are attached below on either side of the summit of the dens and pass upwards and lateralwards to be attached to the medial aspects of the condyles of the occipital bone.

The *ligamentum apicis dentis* extends from the summit of the dens to the anterior margin of the foramen magnum.

The *articulation between the atlas and the epistropheus* comprises: (1) the articulation between the dens and the anterior arch of the atlas, which is a pivot joint; and (2) the articulation between the inferior articular processes of the atlas and the superior articular processes of the epistropheus, which are arthrodial joints. The ligaments connecting these bones are :—

(1) The *anterior longitudinal ligament*. It is the continuation upwards of the anterior longitudinal ligament of the vertebral column and extends from the anterior surface of the body of the epistropheus to the lower border of the anterior arch of the atlas.

(2) The *ligamenta flava* correspond to the ligamenta flava connecting the vertebral arches and connect the upper borders of the laminæ of the epistropheus to the lower border of the posterior arch of the atlas.

(3) The *articular capsules* are loose and surround the inferior articular processes of the atlas and the superior articular processes of the epistropheus. Each is lined by a synovial stratum and strengthened by an accessory ligament extending from the posterior aspect of the base of the dens to the postero-medial aspect of the lateral

mass of the atlas.

(4) The *transverse ligament of the atlas* stretches across the ring of the atlas and is attached on either side to the medial aspect of the lateral mass of the bone. It holds the dens in contact with the anterior arch of the atlas.

Opposite the posterior surface of the dens a vertical limb, called the *superior crus*, passes upwards to the anterior margin of the foramen magnum and another vertical limb called the *inferior crus* passes downwards to the posterior surface of the body of the epistropheus. The superior crus has been already cut and reflected to expose the ligamentum apicis dentis. If the superior crus is replaced, the transverse ligament with its two vertical limbs will be seen to constitute what is called the *ligamentum cruciatum atlantis*.

There is a *synovial stratum* between the anterior surface of the dens and the anterior arch of the atlas and another between the posterior surface of the dens and the transverse ligament.

The articulations of the lower five cervical vertebræ and the ligaments connecting them are the same as seen in the thoracic or lumbar region (p. 216).

THE ORBIT.

Before commencing the dissection of the orbit, the student should first study the bony orbit, its roof, floor, medial and lateral walls, base, and apex.

The following structures have to be examined in the dissection of the orbit.

I. Muscles.—(1) The levator palpebræ superioris, (2) the four recti muscles and (3) the two obliqui muscles.

II. Vessels.—The ophthalmic artery and its branches and the ophthalmic veins.

III. Nerves.—(1) The oculomotor, trochlear, and abducent nerves; (2) the three branches of the ophthalmic division of the trigeminal nerve; (3) the zygomatic branch of the maxillary nerve; and (4) the optic nerve.

IV. The lacrimal gland.

V. The fascia bulbi.

The cavity of the orbit is to be opened by removing the bone forming its roof. The saw is to be applied through the frontal bone (1) at the medial end of the supraorbital margin and (2) at its articulation with the zygomatic bone. Then with a chisel the saw cuts are to be continued backwards so as to meet close in front of the optic foramen, the bony ring of the foramen being left intact. By a few gentle strokes of the hammer the portion of bone included between these cuts is to be loosened and tilted forwards. Any small projection of bone if left behind to interfere with the dissection should be removed. The projecting anterior clinoid process should be taken away. And lastly during the dissection of the orbital cavity the eye ball should be hooked forwards and kept in this position.

The *periosteum* covering the undersurface of the roof of the orbit is now exposed. It is loosely attached to the walls of the orbit and continuous posteriorly with the dura mater inside the cranial cavity through the superior orbital fissure and the optic foramen. In front it is continuous with the periosteum lining the exterior of the skull. Its connections with the orbital septum have been described (p. 312).

The periosteum is to be divided antero-posteriorly along the middle line and transversely close to the supraorbital margin. Reflect the flaps medially and laterally. After some fat has been removed the dissector will observe the lacrimal gland at the lateral and front part of the orbit, the frontal nerve and the supraorbital artery

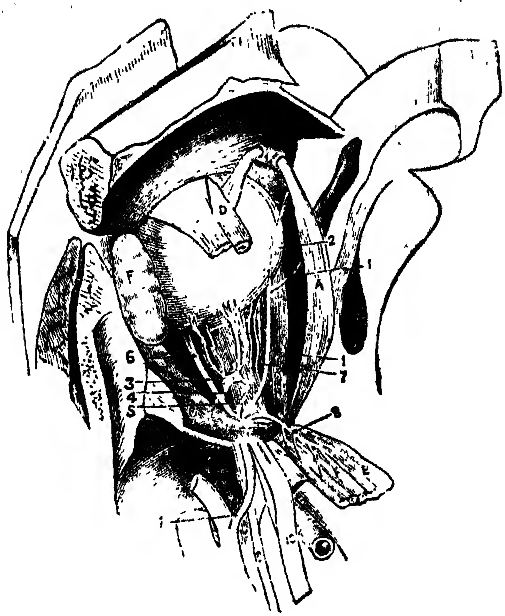


Fig. 73.—Dissection of the orbit (Ellis).

A. Superior oblique.
B. Levator palpebræ and superior rectus reflected.
C. Lateral rectus.
D. Front portion of superior rectus.
E. Lacrimal gland.
1. Nasociliary nerve.
2. Its infratrochlear branch.
3. Ciliary ganglion.
4. Its short root.
5. Its long root.
6. Branch of oculomotor nerve to inferior oblique muscle.
7. Ciliary branches of nasociliary nerve.
8. Upper division of oculomotor nerve.
9. Abducent nerve.
10. Oculomotor nerve outside the orbit.

along the middle line, the lacrimal nerve and artery on the lateral side, and the trochlear nerve on the medial side. The levator palpebræ lies upon the superior rectus along the middle line and the superior oblique muscle on the medial side.

The **Lacrimal Gland** has been partly described (p. 314). Its two portions superior and inferior, separated from each other by the expanded tendon of the levator palpebræ superioris can now be fully examined. The *superior lacrimal gland* lies against the lacrimal fossa of the frontal bone. The *inferior lacrimal gland* lies against the back part of the upper eyelid below and in front of the superior portion of the gland.

The **Frontal Nerve** is the largest of the three branches of the ophthalmic nerve. Entering the orbit through the superior orbital fissure, it runs forwards between the levator palpebræ superioris and the periosteum and terminates about the middle of the orbit by dividing into two branches, the supratrochlear and the supraorbital. The *supratrochlear nerve* passes forwards and medialwards above the pulley of the superior oblique muscle and piercing the orbital septum emerges from the orbit at its upper and medial angle (p. 224). The *supraorbital nerve* passes forwards and leaves the orbit through the the supraorbital notch (p. 224).

The **Lacrimal Nerve** is placed on the lateral side of the frontal nerve and along the upper margin of the lateral rectus muscle and passes to the lacrimal gland, the deep surface of which it supplies. Passing beneath the lacrimal gland it pierces the orbital septum and supplies the skin of the upper eyelid. Near the lacrimal gland it gives a twig which passes downwards to communicate with the zygomatic branch of the maxillary nerve.

The **Trochlear Nerve** enters the orbit through the superior orbital fissure and passing medialwards above the origin of the levator palpebræ superioris ends in the back part of the superior oblique muscle on its superficial surface.

Divide the frontal nerve and reflect its ends forwards and backwards.

The **Levator Palpebræ Superioris** arises from the undersurface of the roof of the orbit just above and in front of the optic foramen. It is pointed at its origin and widens in front into an expansion, the insertion of which has been described (p. 313). It is supplied by the superior division of the oculomotor nerve which enters its deep surface.

The **Superior Oblique** arises from the upper and medial margin of the optic foramen above and medial to the origin of the preceding muscle. It passes forwards towards the upper and medial angle of the orbit and ends in a tendon which passes through a fibrocartilaginous ring, called the *trochlea* or *pulley*, attached to the trochlear fossa of the frontal bone. It then suddenly changes its direction downwards, backwards and lateralwards under cover of the superior rectus and becomes inserted into the sclera between the superior and lateral recti muscles. It is supplied by the trochlear nerve. The trochlea is lined by a mucous sheath which facilitates the movement of the tendon inside it.

Divide the levator palpebræ superioris and reflect its ends forwards and backwards. The superior rectus muscle is seen.

The **Rectus Superior** arises from that part of the fibrous ring which is attached to the upper margin of the optic foramen and is inserted into the sclera at its upper and anterior part about one fourth of an inch behind the sclero-corneal junction. It is supplied by a branch from the superior division of the oculomotor nerve which enters its deep surface.

Divide the superior rectus about its middle and reflect the cut ends forwards and backwards. On removing a quantity of fat the optic nerve is seen. The naso-ciliary nerve, the ophthalmic artery and the superior ophthalmic vein are to be followed as they cross the optic

nerve. At the back part of the orbit on the lateral side of the optic nerve look for the small ciliary ganglion. This ganglion will be reached if its long root coming from the nasociliary nerve or its short root coming from the branch of the inferior division of the oculomotor nerve supplying the inferior oblique muscle is traced.

The **Nasociliary Nerve** (Nasal nerve) enters the orbit between the two heads of the rectus lateralis and crossing the optic nerve passes medialwards between the rectus medialis and superior oblique muscles to enter the anterior ethmoidal foramen, under the name of the *anterior ethmoidal nerve.* Passing through this foramen it enters the cranial cavity and passes forwards along the lateral edge of the cribriform plate of the ethmoid bone under cover of the dura mater. It then enters the nasal cavity through a slit by the side of the crista galli and runs downwards along the inner surface of the nasal bone. Here it gives off *internal nasal branches* to the mucous membrane of the nose. Finally it leaves the nasal fossa and appears on the face as the *external nasal nerve* between the lower border of the nasal bone and the lateral cartilage of the nose (p. 309). The following branches are given off from the nasociliary nerve :—(1) The *long root of the ciliary ganglion* which arises between the two heads of the rectus lateralis and passes along the lateral side of the optic nerve to join the postero-superior angle of the ciliary ganglion. Sometimes the sympathetic root from the cavernous plexus joins the long root. (2) The *long ciliary nerves* which are two or three in number and arise from the nasociliary as it crosses the optic nerve and proceed forwards to the eyeball where they pierce the back part of the sclera to supply the ciliary muscle, iris and cornea. (3) The *posterior ethmoidal nerve* passes through the posterior ethmoidal foramen to supply the ethmoidal cells and the sphenoidal sinus. (4) The *infratrochlear nerve*

arises from the nasociliary just before it enters the anterior ethmoidal foramen and passes beneath the superior oblique muscle and its trochlea. It then leaves the orbit and appears on the face (p. 309). Near the pulley it is joined by a filament from the supratrochlear nerve.

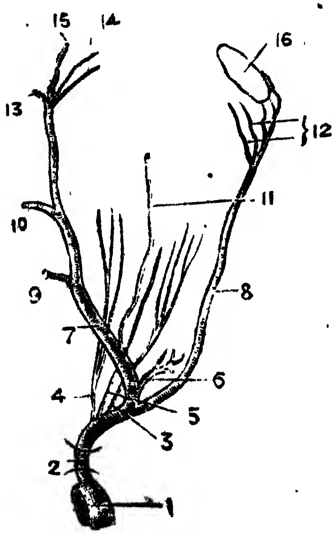
The **Ciliary Ganglion** (Lenticular ganglion) is a minute reddish body of the size of a pin's head and situated at the back part of the orbit between the rectus lateralis and the optic nerve. It is quadrangular in shape. Like other cranial ganglia it has three roots which enter its posterior border. The short or *motor root* is thick and derived from the branch of the inferior division of the oculomotor nerve which goes to supply the inferior oblique muscle. It joins the postero-inferior angle of the ganglion. The long or *sensory root* is slender and joins the postero-superior angle of the ganglion. It is derived from the nasociliary nerve. The *sympathetic root* is derived from the cavernous plexus of the sympathetic and joins the ganglion below the sensory root; sometimes it joins the sensory root. The branches of the lenticular ganglion are the *short ciliary nerves* which arise from the anterior border of the ganglion. They are six to ten in number and are arranged in two groups; an upper group, running above the optic nerve and a lower group, below that nerve. They pierce the sclera around the optic nerve to supply the iris, cornea and the ciliary muscle.

The **Optic Nerve** enters the orbit through the optic foramen and lies above and medial to the ophthalmic artery. It passes through the centre of the orbit surrounded by the recti muscles and pierces the back of the sclera a little to the medial side of its centre and expands into the retina inside the eyeball.

The **Ophthalmic Artery** arises from the internal carotid artery on the medial side of the anterior clinoid process and enters the orbit through the optic foramen in com-

pany with the optic nerve lying immediately below and lateral to it. The vessel then crosses the optic nerve obliquely from its lateral to the medial side, runs forwards along the medial wall of the orbit beneath the lower border of the superior oblique muscle and divides into two terminal branches, the frontal and dorsal nasal arteries.

Branches.—(1) The *lacrimal artery* arises near the optic foramen and passes forwards in company with the lacrimal nerve to the lacrimal gland which it supplies as well as the conjunctiva. It gives off two *lateral palpebral branches* which run medialwards one in each eyelid near its free margin and form an arterial arch, *arcus tarsus*, by anastomosing with the medial palpebral branches of the ophthalmic artery of the opposite side. It also gives off muscular branches to the neighbouring muscles; one



1. Internal carotid artery.
2. Ophthalmic artery.
3.4. Posterior ciliary arteries.
5. Arteria centralis retinæ.
6. Muscular branches.
7. Ophthalmic artery.
8. Lacrimal artery.
9. Posterior ethmoidal artery.
10. Anterior ethmoidal artery.
11. Supraorbital artery.
12. Lateral palpebral arteries.
13. Dorsal nasal artery.
14. Medial palpebral arteries.
15. Frontal artery.
16. Lacrimal gland.

Fig. 74—Diagram of the ophthalmic artery and its branches (Buchanan).

or two *zygomatic branches* which emerge from the orbit through a foramen in its lateral wall and a *recurrent branch* which enters the cranial cavity through the lateral part of the superior orbital fissure to supply the duramater. (2) The *arteria centralis retinæ* is a very small branch which pierces the undersurface of the optic nerve about half an inch behind the eyeball and proceeds forwards to the retina in the substance of the nerve. (3) The *muscular branches* supply the muscles of the orbit. Some of them arise from the parent trunk while others are derived from its lacrimal and supraorbital branches. These muscular branches give off the *anterior ciliary arteries* which form an arterial anastomosis beneath the conjunctiva and then pierce the sclera behind the sclerocorneal junction. (4) The *posterior ciliary arteries* arise by two trunks which subdivide into numerous branches. These branches pierce the sclera around the entrance of the optic nerve to supply the chorioid and ciliary processes. Two of these branches are longer than the others and are called the *long posterior ciliary arteries*. (5) The *supraorbital artery* accompanies the nerve of the same name between the periosteum and the levator palpebræ superioris and reaches the forehead through the supraorbital notch or foramen (p. 223). In the orbit it gives off muscular branches to the neighbouring muscles. (6) The *anterior ethmoidal artery* accompanies the anterior ethmoidal nerve through the anterior ethmoidal foramen and supplies the anterior and middle ethmoidal cells and the frontal sinus. Inside the cranium it gives off an *anterior meningeal branch* (p. 242) which supplies the dura mater. In the nasal cavity it gives off nasal branches to supply the mucous membrane of the nose and appears on the side of the nose between the lower border of the nasal bone and the lateral nasal cartilage. (7) The *posterior ethmoidal artery* passes through the posterior

ethmoidal foramen, supplies the posterior ethmoidal cells and gives off some twigs which, passing through the apertures in the cribriform plate of the ethmoid, supply the upper part of the nasal cavity. Inside the cranium it gives off a small meningeal branch. (8) The *medial palpebral arteries* are two in number, a superior and an inferior. They arise close to the pulley of the superior oblique and run lateralwards, one in each eyelid, near its free margin to anastomose with the lateral palpebral branches already described. (9) The *frontal artery* is one of the terminal branches and accompanies the supratrochlear nerve (p. 222). (10) The *dorsal nasal artery* is the other terminal branch. It leaves the orbit at its medial angle to supply the outer surface of the root of the nose and anastomose with the angular artery.

The **Ophthalmic Veins** are two in number, superior and inferior. The *superior ophthalmic vein* receives tributaries corresponding to the branches of the ophthalmic artery. It begins at the medial angle of the orbit as the nasofrontal vein which communicates with the angular vein. It accompanies the ophthalmic artery receiving tributaries corresponding to the branches of the artery, passes backwards between the two heads of the rectus lateralis and opens into the cavernous sinus. Before its termination it is usually joined by the inferior ophthalmic vein. The *inferior ophthalmic vein* is formed at the front part of the floor of the orbit by some minute veins. It runs backwards below the eyeball and the optic nerve and receiving some tributaries divides into two branches. One of these communicates with the pterygoid venous plexus through the inferior orbital fissure and the other joins the superior ophthalmic vein before it opens into the cavernous sinus.

Recti and the Common Fibrous Ring.—A fibrous or tendinous ring surrounds the optic foramen which is the

common origin of the four recti muscles. This ring is attached to the upper, medial and lower margins of the optic foramen. From the lower margin it passes lateralwards bridging over the medial end of the superior orbital fissure and becomes attached to the tubercle on the margin of the great wing of the sphenoid forming the lower boundary of the fissure. From this tubercle the band passes to the upper and lateral parts of the optic foramen, thus completing the ring. The *rectus superior* has been examined. The *rectus medialis* arises from the part of the fibrous ring on the medial margin of the optic foramen. The *rectus inferior* arises from the part of the fibrous ring which extends along the lower margin of the optic foramen. The *rectus lateralis* arises by two heads, a superior and an inferior. The superior head arises from the lateral part of the fibrous ring above the optic foramen. The inferior head arises from the lateral part of the fibrous ring below the optic foramen and the tubercle on the great wing of the sphenoid bone which bounds the superior orbital fissure below. Between these two heads the superior and inferior divisions of the oculomotor nerve, the nasociliary nerve, the abducent nerve and the ophthalmic veins pass. Each rectus muscle is inserted by a membranous tendon into the sclera on the corresponding side of the eyeball about one fourth of an inch behind the sclerocorneal junction. The rectus lateralis is supplied by the abducent nerve which enters its ocular surface; the medial and inferior recti are supplied by the inferior division of the oculomotor nerve.

The **Abducent Nerve** passes between the two heads of the rectus lateralis and enters the ocular surface of the muscle to supply it.

The **Oculomotor Nerve** breaks up into a superior and an inferior division before entering the superior orbital fissure. These two divisions then enter the orbit through

that fissure between the two heads of the rectus lateralis. The *superior division* has been seen to pass above the optic nerve and supply the levator palpebræ superioris and superior rectus muscles. The *inferior division* breaks up into three branches for the supply of the rectus medialis, the rectus inferior and obliquus inferior. The nerve to the last named muscle is long and gives off the short or motor root to the ciliary ganglion. It passes forwards between the rectus inferior and the rectus lateralis to enter the posterior border of the inferior oblique muscle.

To expose the inferior oblique muscle divide the conjunctiva at the inferior fornix and clean the muscle at the anterior part of the floor of the orbit.

The **Inferior Oblique Muscle** arises from a depression on the orbital surface of the maxilla just lateral to the aperture for the nasolacrimal duct. It passes lateralwards, backwards and upwards at first between the inferior rectus and the floor of the orbit, and then between the eyeball and rectus lateralis to be inserted into the lateral aspect of the sclera between the lateral and superior recti. It is supplied by the inferior division of the oculomotor nerve.

The **Fascia Bulbi** (capsule of Tenon) is a membrane which covers the sclera from the optic nerve behind to the sclerocorneal junction in front. Its inner surface is smooth and is separated from the sclera by periscleral lymph space containing loose areolar tissue. Its external surface is covered by the fatty tissue of the orbit. Posteriorly it is pierced by the ciliary vessels and nerves and by the optic nerve with the sheath of which it is continuous. Anteriorly it is blended with the ocular conjunctiva near the margin of the cornea. It is perforated by the tendons of the ocular muscles which are inserted into the sclera and is prolonged backwards on them as tubular sheaths. The fascia bulbi is strengthened at its lower

part by the *suspensory ligament* (Lockwood) which stretches across the orbit being attached medially to the lacrimal bone and laterally to the zygomatic bone. The tubular sheaths on the medial and lateral recti are attached by processes, called *check ligaments*, to the lacrimal and zygomatic bones respectively.

MOUTH, PHARYNX AND PALATE.

The **Mouth** consists of an outer portion called the vestibule and an inner portion called the cavity proper of the mouth. The *vestibule* of the mouth is a slit-like space bounded in front by the lips and cheeks and behind by the gums and teeth. In front it presents the orifice of the mouth and the parotid ducts open into it posteriorly. It communicates with the cavity of the mouth proper behind the last molar teeth. The *cavity proper* of the mouth is bounded in front and laterally by the teeth and gums covering the alveolar arches. Behind it leads to the pharynx through the isthmus of the fauces. Its floor is formed by the tongue and the mucous membrane extending from the organ to the inner aspect of the mandible. Its roof is formed by the hard and soft palates. The ducts of the submaxillary and sublingual glands open into it.

The **Lips** (Labia oris) are lined externally by skin and internally by mucous membrane and enclosed between them are the orbicularis oris with the facial muscles converging into it, the labial glands and vessels. The fold of the mucous membrane in the middle line connecting the inner aspect of each lip with the gum covering the corresponding alveolar arch is called the *frenulum labii.*

The **Cheeks** (buccæ) are lined externally by skin and internally by the mucous membrane of the mouth and between them are enclosed muscles (chiefly the buccinator),

branches of the facial artery and nerve, and buccal glands.

The **Gums** cover the alveolar processes and surround the necks of the teeth. They are composed of dense fibrous tissue covered by mucous membrane.

The **Teeth** are thirty two in number, sixteen in each jaw, viz., four incisors, two canines, four premolars or bicuspids and six molars. Each tooth consists of (1) the crown, the portion projecting above the level of the gum; (2) the neck, the part surrounded by the gum; and (3) the root, the portion embedded within the alveolus.

The **Isthmus of the Fauces** is the opening by which the cavity of the mouth communicates with the pharynx. It is bounded above by the soft palate, below by the dorsum of the tongue and on either side by an arched fold of mucous membrane called the glossopalatine arch. The *glossopalatine arch* (anterior pillar of the fauces) is formed by the glossopalatinus covered by mucous membrane and extends from the soft palate downwards, lateralwards and forwards to the side of the tongue.

The **Pharynx** is a musculo-membranous tube, about five inches in length, extending from the base of the skull to the body of the sixth cervical vertebra. Its greatest breadth is opposite the hyoid bone; its narrowest portion is opposite the cricoid cartilage where it becomes continuous with the œsophagus. Above it is attached to the base of the skull; behind it is connected by loose areolar tissue with the prevertebral fascia. In front the pharynx is deficient where it communicates with the nasal cavities, the mouth and the larynx, and is limited by its attachment on either side from above downwards to the medial pterygoid lamina, the pterygomandibular raphe, the mandible, the tongue, the hyoid bone and the thyreoid and cricoid cartilages. Laterally it is in relation with the styloid process and the muscles attached to it, and the great vessels and nerves of the neck.

Distend the wall of the pharynx by stuffing it with tow.

Structure of the pharynx.—The wall of the pharynx is composed of the following layers from without inwards: (1) buccopharyngeal fascia, (2) pharyngeal venous plexus, (3) muscular layer, (4) fibrous layer or pharyngeal aponeurosis, and (5) mucous membrane.

The *buccopharyngeal fascia* covers the pharynx and the buccinator and has been described (p. 378). The *pharyngeal venous plexus* is formed by a number of small veins ramifying and joining with each other upon the muscular wall of the pharynx. This plexus terminates in two or more pharyngeal veins which open into the internal jugular vein. The *muscular layer* is composed of the three constrictor muscles and the stylopharyngeus, pharyngopalatinus and salpingopharyngeus muscles.

Clean the surfaces of the constrictor muscles by removing the remains of the buccopharyngeal fascia and the pharyngeal plexuses of veins and nerves.

The **Constrictor Muscles** of the pharynx are three in number, superior, middle and inferior.

The *inferior constrictor muscle* arises (1) from the side of the cricoid cartilage, (2) from the inferior cornu and oblique line of the thyreoid cartilage, and (3) from the surface of the cartilage behind the oblique line. The fibres from these origins pass in an arched manner backwards and medialwards and become inserted into the postero-median raphe of the pharynx. The lower fibres are horizontal and continuous with the circular fibres of the œsophagus. The upper fibres are oblique and overlap the lower part of the middle constrictor. The internal laryngeal nerve lies near the upper border and the recurrent nerve near the lower border of the muscle prior to their entrance into the larynx.

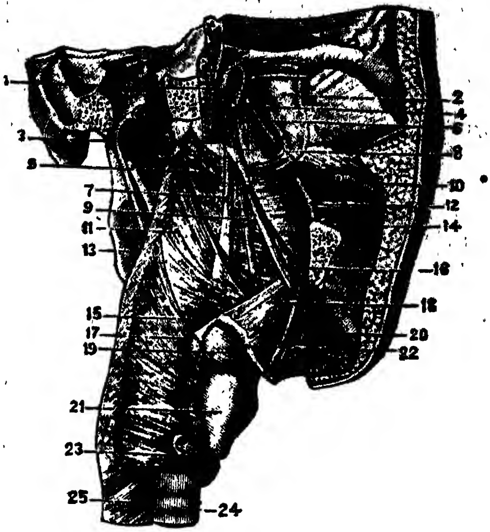


Fig. 75.—Side view of the pharynx (from Sappey).

1. Auditory tube.
2. Lateral pterygoid lamina.
3. Left styloid process.
4. Tensor veli palatini.
5. Superior constrictor.
6. Levator veli palatini.
7. Stylopharyngeus, upper part.
8. Right styloid process.
9. Stylohyoid muscle.
10. Parotid duct.
11. Middle constrictor.
12. Pterygomandibular raphe.
13. Internal pterygoid muscle.
14. Buccinator muscle.
15. Stylopharyngeus, lower part.
16. Styloglossus.
17. Inferior constrictor.
18. Hyoglossus.
19. Hyothyreoid membrane.
20. Mylohyoid muscle.
21. Thyreoid cartilage.
22. Hyoid bone.
23. Cricothyreoid muscle.
24. Trachea.
25. Œsophagus.

The *middle constrictor muscle* is triangular in shape and arises by its narrow end (1) from the upper border of the greater cornu of the hyoid bone, (2) from the lesser cornu, and (3) from the lower end of the stylohyoid ligament. The fibres diverge backwards and medialwards in a fan-shaped manner and become inserted into the

postero-median raphe. The lower fibres are overlapped by the inferior constrictor and the upper fibres overlap the superior constrictor muscle.

The *superior constrictor muscle* is quadrilateral in shape and arises (1) from the lower third of the posterior border of the medial pterygoid lamina and its hamulus, (2) from the pterygomandibular raphe, (3) from the posterior end of the mylohyoid line of the mandible, and (4) from the side of the tongue. The fibres arch backwards and medialwards and are inserted into the posteromedian raphe—the highest fibres being attached to the pharyngeal spine on the basilar portion of the occipital bone. The upper border of the muscle is concave and does not reach the base of the cranium; the gap (sinus of Morgagni) is filled up by the pharyngobasilar fascia and transmits the levator veli palatini and the auditory tube. The lower border of the muscle is overlapped by the middle constrictor and between the two muscles in this situation, the stylopharyngeus proceeds to its insertion.

The constrictor muscles are supplied by the pharyngeal plexus of nerves, the inferior constrictor receiving additional branches from the external laryngeal and recurrent nerves.

The pharyngopalatinus and the salpingopharyngeus will be studied later on.

The **Pharyngeal Aponeurosis** forms the fibrous layer of the wall of the pharynx lying between the muscular layer and the mucous membrane. At the upper part of the pharynx between the concave upper margin of the superior constrictor and the base of the cranium where the muscle fibres are deficient it is thick and strong and is called the *pharyngobasilar fascia*, which is attached above to the basilar portion of the occipital bone and the petrous portion of the temporal bone. As it descends

it gradually diminishes in thickness and is very thin at the lower part.

Lay open the pharynx by a vertical incision in the middle line along its posterior wall and then divide it transversely near its attachment to the base of the skull.

The student should note that the pharynx may be subdivided from above downwards into three portions; (1) the nasal portion lying above the level of the soft palate, (2) the oral portion lying below the level of the soft palate between it and the hyoid bone, and (3) the laryngeal portion from the level of the hyoid bone to that of the cricoid cartilage. The mucous membrane lining these three portions should now be studied.

The **Nasal Portion** (nasopharynx) is the uppermost part of the pharynx and communicates in front with the nasal cavities by the choanæ. On the lateral wall at the lower and back part of the choanæ is seen on either side the *ostium pharyngeum* or pharyngeal opening of the auditory tube. This opening is bounded behind by an elevation called the *torus tubarius* (Eustachian cushion). From the lower part of the torus an elevated fold of mucous membrane called the *salpingopharyngeal fold* descends vertically along the lateral wall of the pharynx. This prominence is caused by the salpingopharyngeus muscle covered by mucous membrane. Behind the torus is a depression called the *pharyngeal recess* (fossa of Rosenmuller). The mucous membrane of the posterior wall presents a collection of lymphoid tissue called the *pharyngeal tonsil.* The *roof* is formed by the basilar portion of the occipital bone and the basisphenoid covered by mucous membrane, and the *floor* by the upper surface of the soft palate.

The **Oral Portion** communicates in front with the cavity of the mouth through the isthmus of the fauces. On its lateral wall behind the glossopalatine arch is seen on either

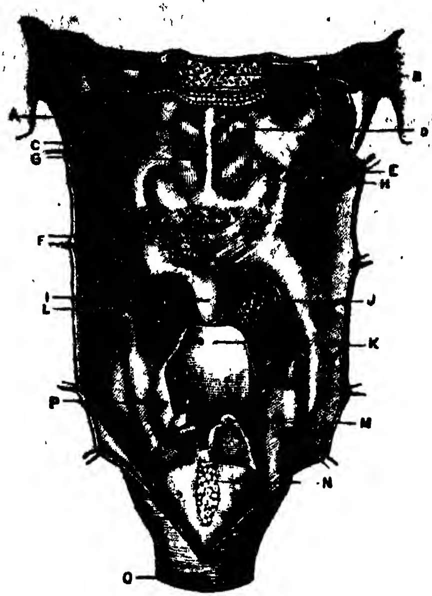


Fig. 76.—Pharynx laid open from behind (Sappey).

A. Styloid process.
B. Occipital bone.
C. Septum nasi.
D. Middle nasal concha.
E. Inferior nasal concha.
F. Soft palate.
G. Choana.
H. Auditory tube.
I. Uvula.
J. Palatine tonsil.
K. Epiglottis.
L. Back of tongue.
M. Tip of arytænoid cartilage.
N. Back of cricoid cartilage.
O. Œsophagus.
P. Aryepiglottic fold.

side another arched fold called the *pharyngopalatine arch* (posterior pillar of the fauces). It extends from the soft palate downwards, lateralwards and backwards to the lateral wall of the pharynx and is caused by the pharyngopalatinus muscle covered by mucous membrane. Between the glossopalatine arch in front and the pharyngopalatine arch behind is a triangular depression at the lower part called the *sinus tonsillaris* which lodges the palatine

tonsil. The upper part of the sinus tonsillaris above the level of the palatine tonsil is called the *supratonsillar fossa.*

The **Laryngeal Portion** of the pharynx presents in its anterior wall the superior aperture of the larynx. This aperture is triangular in shape and its base is formed by the upper border of the epiglottis and the sides by two folds of mucous membrane called the aryepiglottic folds which extend from the lateral margins of the epiglottis to the arytænoid cartilages. On the lateral side of each aryepiglottic fold is a recess called the *sinus piriformis* which is bounded laterally by the thyreoid cartilage and the hyothyreoid membrane.

The **Soft Palate** is a musculomembranous partition which intervenes between the cavity of the mouth and the nasal part of the pharynx.. It consists of a fold of mucous membrane, between the two layers of which are enclosed a number of muscles, an aponeurosis, vessels, nerves and mucous glands. Its anterior margin is attached to the posterior border of the hard palate. Its posterior margin is free and from the centre of it hangs a conical projection called the *uvula.* Laterally it is blended with the sides of the pharynx. Its upper surface is convex and is continuous with the floor of the nasal cavities ; its under surface is concave and is continuous with the roof of the mouth.

To dissect the muscles the soft palate should be made tense by means of hooks and the mucous membrane from its upper and lower surfaces is to be removed. The muscles are the musculus uvulæ, the levator veli palatini, the tensor veli palatini, the glossopalatinus and the pharyngopalatinus.

The Musculus Uvulæ (Azygos uvulæ) arises from the posterior nasal spine of the palatine bone and is inserted after uniting with its fellow of the opposite side into the

submucous tissue of the uvula.

The **Levator Veli Palatini** (Levator palati) arises (1) from the rough area on the under surface of the petrous bone and (2) from the medial lamina of the cartilage of the auditory tube. It passes downwards and forwards, pierces the pharyngobasilar fascia close to the upper border of the superior constrictor muscle and is inserted into the soft palate and into the palatine aponeurosis. The posterior fibres of the muscle are continuous with the corresponding fibres of the opposite side across the midlde line.

The **Tensor Veli Palatini** (Tensor palati) arises (1) from the scaphoid fossa at the base of the medial pterygoid lamina, (2) from the medial aspect of the spina angularis, and (3) from the lateral lamina of the cartilage of the auditory tube. It passes vertically downwards along the lateral surface of the medial pterygoid lamina and ends in a tendon which passes horizontally medialwards hooking round the pterygoid hamulus. The tendon then expands and is inserted into (1) the palatine aponeurosis and (2) into the transverse ridge and the surface of bone behind it on the undersurface of the palatine bone.

The **Glossopalatinus** (Palatoglossus) arises from the undersurface of the palatine aponeurosis where its fibres are continuous with those of the opposite side across the middle line. It passes downwards, lateralwards and forwards to be inserted into the posterior part of the side of the tongue.

The **Pharyngopalatinus** (Palatopharyngeus) at its origin from the soft palate consists of two strata, an upper and a lower. The *upper stratum* is the uppermost muscular layer in the soft palate lying just beneath the mucous membrane and is continuous across the middle line with the corresponding stratum of the opposite side. The

lower stratum arises from the posterior border of the palatine bone, and from the palatine aponeurosis; some of the fibres are continuous with those of the opposite side along the middle line. Between these two strata are enclosed the musculus uvulæ and the levator veli palatini. At the lateral border of the soft palate these two strata unite and are reinforced by another muscular slip, the *salpingo-pharyngeus* muscle, which arises from the lower border of the cartilage of the auditory tube. The muscle passes downwards and backwards forming with the overlying mucous membrane, the pharyngo-palatine fold. It blends with the stylopharyngeus and becomes inserted into the posterior border of the thyreoid cartilage and into the lateral wall of the pharynx.

Nerve-supply.—The tensor veli palatini is supplied by a twig from the otic ganglion. The remaining muscles of the soft palate are supplied by the pharyngeal plexus.

The **Palatine Aponeurosis** is a strong fibrous membrane which supports the muscles of the soft palate. In front it is attached to the posterior border of the hard palate where it is thick. It becomes very thin behind and cannot be demonstrated near the free margin of the soft palate.

Vessels of the Soft Palate.—These are three in number; (1) the ascending palatine branch of the external maxillary artery (p. 336), (2) the palatine branch of the ascending pharyngeal artery (p. 363), and (3) the descending palatine branch of the internal maxillary artery (p. 415).

Nerves of the Soft Palate.—The nerves supplying the muscles of the soft palate have been already noted. The posterior and middle palatine nerves descend from the sphenopalatine ganglion and supply the mucous membrane of the soft palate.

The **Auditory Tube** establishes communication between the tympanic cavity and the nasal part of the pharynx.

It is about one and a half inches in length. The lateral third of the tube is bony, whereas the medial two-thirds is formed partly by cartilage and partly by fibrous tissue. On removing the mucous membrane of the pharynx the cartilaginous and fibrous portion of the tube will be exposed. The tube passes backwards, lateralwards and slightly upwards from the pharynx. The cartilaginous portion is formed by the folding of a triangular lamina of fibrocartilage in such a way that the medial and upper walls are formed by it, leaving a gap in the lateral and lower walls which is filled up by fibrous tissue. A muscular slip, called the *dilator tubæ*, arises from the lateral margin of the cartilage and descends to join the tensor veli palatini. The lumen of the tube is widest at the pharyngeal opening and narrowest at the junction of the cartilaginous and bony portions. This narrowest part is called the *isthmus*.

The **Palatine Tonsils** are two rounded bodies of lymphoid tissue placed in the sinus tonsillaris, one on each side. The *external surface* of each tonsil is embedded in some loose connective tissue which lies against the superior constrictor of the pharynx. The *internal surface* presents many minute orifices leading into crypts or recesses. The student should note that the tonsil lies in close relation to the internal carotid artery which lies behind and lateral to it. The arteries supplying the tonsil are the dorsalis linguæ branch of the lingual, the ascending palatine and tonsillar branches of the external maxillary, the ascending pharyngeal artery and the descending palatine branch of the internal maxillary artery.

DISSECTION OF THE CAROTID CANAL.

To expose the carotid canal in the petrous portion of

the temporal bone remove its inferior wall with the bone forceps.

The **Internal Carotid Plexus** is placed on the lateral side of the internal carotid artery in the carotid canal. The dissector has traced the internal carotid nerve derived from the superior cervical ganglion of the sympathetic trunk lying with the internal carotid artery up to the inferior opening of the carotid canal. In the canal the internal carotid nerve divides into two branches, a medial and a lateral. The lateral branch breaks up into filaments to form the *internal carotid plexus* on the lateral side of the artery. The medial branch gives off filaments to the internal carotid plexus and enters the wall of the cavernous sinus to form the *cavernous plexus*. Occasionally a minute ganglion (*carotid ganglion*) is seen in the internal carotid plexus. *Branches of the internal carotid plexus.*—The plexus communicates with (1) the tympanic plexus by the superior and inferior caroticotympanic branches which join the plexus traversing the posterior bony wall of the carotid canal, (2) with the sphenopalatine ganglion by means of the deep petrosal nerve which pierces the cartilage filling up the foramen lacerum and joins the greater superficial petrosal nerve forming the nerve of the pterygoid canal, (3) with the semilunar ganglion, and (4) with the abducent nerve.

Internal Carotid Artery.—Its petrous portion is now seen. On entering the carotid canal it first ascends vertically and then turns forwards and medialwards. It leaves the canal, enters the cranial cavity at the apex of the petrous bone and, passing across the foramen lacerum, ascends to enter the wall of the cavernous sinus. The tympanic cavity and the cochlea lie behind it, and the semilunar ganglion lies above it near its exit from the canal. A minute branch of the artery, called the *caroticotympanic branch,* enters the tympanic cavity

through a minute foramen in the posterior wall of the canal.

The *carotid plexus of veins* accompanies the internal carotid artery in the carotid canal.

THE OTIC GANGLION.

Reference has been made of the otic ganglion during the dissection of the infratemporal region. This ganglion should now be searched for in the infratemporal region. If the nerve to the internal pterygoid muscle is traced it will lead to the otic ganglion which derives its motor root from that nerve.

The **Otic Ganglion** is a small oval ganglion placed immediately below the foramen ovale on the medial side of the mandibular nerve in front of the middle meningeal artery. Like the other cranial ganglia it has three roots, motor, sensory and sympathetic. The *motor root* is derived from the nerve to pterygoideus internus; the *sensory root*, from the lesser superficial petrosal nerve which joins the ganglion from above and derives sensory fibres from the glossopharyngeal nerve. The *sympathetic root* comes from the plexus around the middle meningeal artery. The *branches* of the otic ganglion are:—(1) branch to the tensor veli palatini which passes forwards and enters the muscle, (2) a twig which passes backwards and supplies the tensor tympani, and (3) communicating filaments to the chorda tympani nerve and to one or both roots of the auriculo-temporal nerve.

DISSECTION OF THE MAXILLARY NERVE.

Remove the temporal muscle as also the origin of the pterygoideus externus. Saw through the skull beginning at the cut margin above the external acoustic meatus

and carry it downwards and forwards towards the medial end of the superior orbital fissure along the lateral side of the foramen rotundum. Another saw-cut is to be made from the sawn margin of the skull above the anterior border of the great wing of the sphenoid bone in a downward direction to the termination of the first

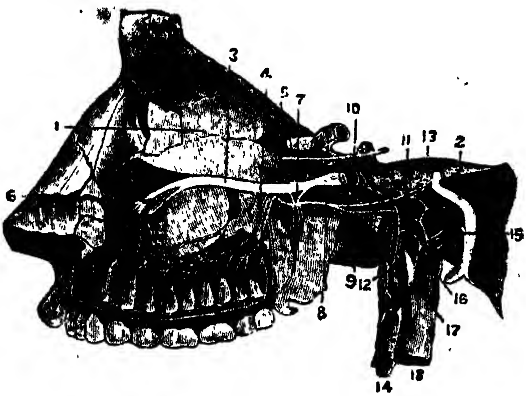


Fig. 77.—Dissection of the maxillary nerve and sphenopalatine ganglion (Hirschfeld and Leveille).

1. Medial wall of orbit.
2. Facial nerve.
3. Maxillary nerve.
4. Posterior superior alveolar nerve.
5. Zygomatic branch (cut).
6. Anterior superior alveolar nerve.
7. Sphenopalatine ganglion.
8. Nerve of pterygoid canal.
9. Deep petrosal nerve.
10. Abducent nerve.
11. Greater superficial petrosal nerve.
12. Internal carotid plexus of sympathetic.
13. Lesser superficial petrosal nerve.
14. Superior cervical ganglion.
15. Chorda tympani nerve.
16. Tympanic branch of glosso-pharyngeal nerve.
17. Glossopharyngeal nerve.
18. Internal jugular vein.

saw-cut. Remove the piece of bone included between these two cuts. And finally remove the periosteum from the floor of the orbit and lay open the whole length of the

infraorbital canal. The zygomatic nerve will be seen lying along the lower part of the lateral wall of the orbit.

Maxillary Nerve (Superior maxillary nerve).—The origin of the nerve from the semilunar ganglion and its course inside the cranium have been examined. It leaves the cranial cavity through the foramen rotundum and, crossing the upper part of the pterygopalatine fossa, inclines lateralwards and enters the orbit through the inferior orbital fissure. It then traverses the infraorbital canal in the floor of the orbit accompanied by the infraorbital vessels assuming the name of the *infraorbital nerve*. It issues out of the infraorbital foramen and appears on the face (p. 309).

Branches.—(1) The *meningeal branch* given off within the cranium has been examined. (2) The *zygomatic nerve* (temporo-malar nerve) arises from the maxillary nerve in the pterygopalatine fossa and, entering the orbit through the inferior orbital fissure, divides into two branches, the zygomatico-temporal and the zygomatico-facial. The *zygomaticotemporal branch* passes along the lateral wall of the orbit and receives a communicating filament from the lacrimal nerve. It issues out of the orbit through a foramen in the zygomatic bone and appears in the temporal fossa. Its distribution to the skin of the temporal region has been examined (p. 224). The *zygomaticofacial branch* also issues out of the orbit through a canal in the zygomatic bone and appears on the face (p. 310). (3) The *sphenopalatine branches*, two in number, constitute the sensory roots of the sphenopalatine ganglion. (4) The *posterior superior alveolar nerve* (posterior superior dental nerve) arises before the maxillary nerve enters the orbit. It divides into two branches which descend along the infratemporal surface of the maxilla and supply filaments to the gum and the mucous membrane of the cheek. They then enter the posterior alveolar

canals and supply the lining membrane of the maxillary sinus (antrum of Highmore) and the three molar teeth. (5) The *middle superior alveolar nerve* arises from the infraorbital nerve at the back part of infraorbital canal and descends through a minute canal in the lateral wall of the maxillary sinus to supply the two premolar teeth. (6) The *anterior superior alveolar nerve* arises from the infraorbital nerve at the front part of the infraorbital canal. It descends through a minute canal in the anterior wall of the maxillary sinus and supplies the incisor and canine teeth.

The *infraorbital artery* which accompanies the infraorbital nerve should be examined now. It is a branch of the internal maxillary artery given off in the pterygopalatine fossa. In the infraorbital canal it gives off the *anterior superior alveolar artery* which accompanies the nerve of the same name. Its termination in the face has been examined. The *infraorbital vein* terminates in the pterygoid venous plexus.

THE NASAL CAVITIES.

The larynx and tongue with the loose piece of the mandible should now be removed from the front part of the skull and kept aside for subsequent examination. The fore part of the skull should then be divided into two lateral halves by sawing it in the sagittal direction. First saw through the roof of the nasal cavity a little to the left of the middle line, so that the septum of the nose remains intact with the right half of the section. Place the roof of the mouth uppermost, divide the soft parts a little to the left of the middle line and saw through the hard palate and the alveolar process of the maxilla to complete the section.

The **Septum of the Nose** forms the medial wall of the

nasal cavities. It is composed partly of bone and partly of cartilage. It is often deflected to one or the other side. The mucous membrane covering it is divisible into two parts; that covering the upper third of the septum is called the *olfactory area* and is thinner than that covering the lower two thirds of the septum, called the *respiratory area.*

The student should next study the constituent parts of the nasal septum. The mucous membrane is to be removed from the whole of the left side of the septum. A macerated skull with the nasal septum exposed should be procured which will facilitate the study of the dissected part.

Formation of the nasal septum. The bones entering into its formation are the crest of the nasal bones and the frontal spine in front; the perpendicular lamina of the ethmoid in the middle, the vomer and the rostrum of the sphenoid behind; and the crest formed by the palatine bones and the palatine processes of the maxillary bones below. The triangular gap left in front between the vomer and the perpendicular lamina of the ethmoid is filled up by the *septal cartilage.* This cartilage is somewhat quadrilateral in shape. Its postero-superior border joins the perpendicular lamina of the ethmoid. Its postero-inferior border joins the vomer and the incisive crest of the maxillæ. Its antero-superior border joins the nasal bones above and the lateral cartilages of the nose below. Its antero-inferior border is connected in front with the medial crura of the greater alar cartilages by fibrous tissue.

Remove the septal cartilage and the thin bones forming the septum of the nose detaching the mucous membrane lining their right lateral surface. Trace the blood vessels and nerves of the septum in the mucous membrane.

Nerves of the Nasal Septum.—The *olfactory nerves* descend through the medial row of foramina in the cribri-

form plate of the ethmoid and supply the upper third of the mucous membrane lining the septum.

The *nasopalatine nerve* is a branch of the sphenopalatine ganglion. It enters the nasal cavity through the sphenopalatine foramen and reaches the septum by passing medialwards across the roof. It then passes downwards and forwards grooving the surface of the vomer and leaves the nasal cavity through the incisive canal. In the roof of the mouth it supplies the mucous membrane covering the hard palate and communicates with the anterior palatine nerve and with its fellow of the opposite side.

The *posterior superior nasal branches* are minute twigs derived from the sphenopalatine ganglion. They enter the nasal cavity through the sphenopalatine foramen and supply the upper and back part of the septum of the nose. The *internal nasal branches* of the anterior ethmoidal nerve supply the front part of the septum of the nose.

The arteries of the nasal cavities are very small and can be distinctly seen in well injected bodies.

Arteries of the Nasal Septum.—These are (1) *the posterior septal branch* which is the continuation of the sphenopalatine artery and accompanies the nasopalatine nerve ; (2) the *nasal branch of the anterior ethmoidal artery* which supplies the front part of the nasal septum ; (3) the *nasal branches of the posterior ethmoidal artery* which descend through the foramina in the lamina cribrosa of the ethmoid and supply the nasal septum ; and (4) the *septal branch of the superior labial artery* which supplies the front part of the nasal septum.

Remove the mucous membrane lining the right side of the nasal septum keeping the nasopalatine nerve intact. The right nasal cavity is now exposed.

Nasal Cavities.—Each nasal cavity presents for exa-

mination a medial wall or septum, a lateral wall, a roof, a floor, an anterior aperture or nostril, and a posterior aperture or choana. The bony boundaries of the nasal cavities should be studied from a macerated skull.

The **Lateral Wall** of the nasal cavity presents in the recent state in front a depression which forms the lateral part of the vestibule of the nose. It is lined by skin bearing coarse hairs called *vibrissæ*. Behind the vestibular part the lateral wall presents three elevations covered by mucous membrane. They are called from above downwards the *superior*, *middle* and *inferior nasal conchæ*. There are recesses below and lateral to these conchæ called the *meatuses*. The student should note that of the three conchæ the superior and middle are parts of the ethmoid bone while the inferior one is an independent bone. Above the superior concha is a depression, called the *sphenoethmoidal recess*, into which the sphenoidal sinus opens. The *superior meatus* is a small fissure between the superior and the back part of the middle conchæ. Into its front part the posterior ethmoidal cells open by one or two small apertures. The *middle meatus* is situated between the middle and inferior conchæ. It leads in front into a depression above the vestibule called the *atrium* of the middle meatus which is bounded above by a ridge called the *agger nasi*. Above and in front the middle meatus leads into a funnel-shaped passage called the *infundibulum* by means of which it communicates with the frontal sinus. On raising or cutting away the middle nasal concha a deep curved groove will be seen in the lateral wall of the middle meatus. This groove is called the *hiatus semilunaris* and in it are seen the openings of the anterior ethmoidal cells and the maxillary sinus. Fine probes may be passed through these openings to ascertain their direction. Above the hiatus semilunaris is a rounded elevation called the *bulla ethmoidalis*.

The middle ethmoidal cells open either on or above the bulla by an aperture. The *inferior meatus* is the longest of the three meatuses. The nasolacrimal duct opens into its front part. A fine probe may be passed through the nasolacrimal duct from above to ascertain the situation of the opening.

The *roof* of the nasal fossa is narrow; it is horizontal in the middle and sloping both anteriorly and posteriorly. Its *floor* is wide, being concave from side to side. The anterior apertures or *nostrils* are oval and open on the face. The posterior apertures or *choanæ* open into the nasal part of the pharynx. The mucous membrane lining the lateral wall is divisible into an upper or olfactory portion lining the superior nasal concha; and a lower or respiratory portion lining the remaining part of the lateral wall. The respiratory portion of the mucous membrane is thick and very vascular.

Nerves in the lateral wall of the nasal cavity.—To expose these nerves the mucous membrane is to be removed. (1) The *olfactory nerves* are fine filaments which ramify on the superior concha and pass through the foramina in the cribriform lamina of the ethmoid to join the olfactory bulb. (2) The *anterior ethmoidal nerve* will be seen in the groove on the medial surface of the nasal bone and from it internal nasal branches pass to supply the mucous membrane of the front part of the lateral wall. (3) The *posterior superior nasal branches* of the sphenopalatine ganglion enter through the sphenopalatine foramen and supply the mucous membrane covering the superior and middle nasal conchæ. (4) The *nasal branch* of the anterior superior alveolar nerve enters the inferior meatus of the nose through an aperture in its lateral wall and supplies the mucous membrane of the front part of the meatus. (5) The *posterior inferior nasal branches* of the anterior palatine nerve are two in number; they enter

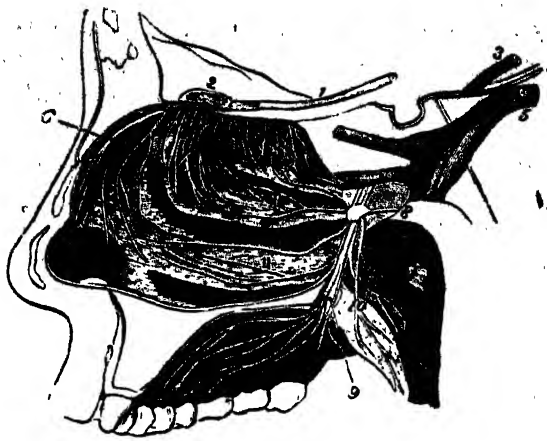


Fig. 78.—Nerves of the lateral wall of the nasal cavity and of the palate (Ellis).

1. Olfactory tract.
2. Olfactory bulb giving branches to the nasal cavity.
3. Oculomotor nerve.
4. Trochlear nerve.
5. Trigeminal nerve.
6. Nasociliary nerve.
7. Sphenopalatine ganglion.
8. Nerve of pterygoid canal.
9. Anterior palatine nerve.
10. Posterior palatine nerve.
11. Posterior inferior nasal branches.

the back part of the lateral wall through apertures in the perpendicular plate of the palatine bone. They supply the mucous membrane over the back part of the inferior nasal concha and the middle and inferior meatuses.

The **Arteries** supplying the lateral wall are (1) the posterior lateral nasal branches of the sphenopalatine artery and (2) the nasal branches of the anterior and posterior ethmoidal arteries.

SPHENOPALATINE GANGLION. TERMINAL PART OF THE INTERNAL MAXILLARY ARTERY.

To expose the sphenopalatine ganglion the mucous

membrane of the lateral wall of the nasal cavity at its back part should be removed, care being taken to preserve the nasopalatine nerve and the posterior superior nasal branches of the ganglion. The sphenopalatine foramen is to be looked for, just lateral to which the ganglion is situated. The thin plate of bone forming the medial wall of the pterygopalatine canal is to be laid open with a chisel. The anterior palatine nerve contained within this canal, if traced upwards will lead to the ganglion. By chipping away the orbital process of the palatine bone and a part of the body of the sphenoid the ganglion will be more satisfactorily exposed.

The **Sphenopalatine Ganglion** (Meckel's ganglion) is triangular in shape and placed in the sphenopalatine fossa just lateral to the sphenopalatine foramen (Fig. 77). It is surrounded by the branches of the terminal portion of the internal maxillary artery. Its *sensory roots* are derived from the two sphenopalatine branches of the maxillary nerve, which join it from above. Its *motor* and *sympathetic roots* are derived through the nerve of the pterygoid canal which join the ganglion posteriorly. The nerve of the pterygoid canal is formed by the union of the greater superficial petrosal and deep petrosal nerves; of these the former contains motor fibres from the facial nerve and the latter contains sympathetic fibres from the internal carotid plexus.

The *branches* of the sphenopalatine ganglion are :—(1) The *posterior superior nasal branches* which arise from the medial aspect of the ganglion and enter the nasal cavity through the sphenopalatine foramen. The largest of these branches is called the *nasopalatine nerve*. It crosses the roof of the nasal cavity medialwards. Its course along the septum of the nose has been examined. The smaller posterior superior nasal branches supply the back part of the septum and the lateral wall of the nose.

(2) The *pharyngeal nerve* arises from the posterior part of the ganglion and passes through the pharyngeal canal to supply the mucous membrane of the nasal part of the pharynx. (3) The *orbital branches* are two or three filaments which enter the orbit through the inferior orbital fissure to supply the periosteum of the orbit. (4) The *palatine nerves* (Fig. 78) are three in number, anterior, middle and posterior. They arise from the lower part of the ganglion. The *anterior palatine nerve* descends through the pterygopalatine canal and, entering the hard palate through the greater palatine foramen, passes forwards and supplies the mucous membrane of the hard palate and the gums. It communicates near the incisive foramen with the terminal filaments of the nasopalatine nerve. It gives off posterior inferior nasal branches which enter the lateral wall of the nasal cavity through apertures in the vertical plate of the palatine bone. The *middle palatine nerve* issues out of one of the lesser palatine foramina in the pyramidal process of the palatine bone and supplies the soft palate and the tonsil. The *posterior palatine nerve* emerges through a separate lesser palatine foramen behind and lateral to the preceding and supplies the soft palate and tonsil

Attempt should now be made to open up the pharyngeal and pterygoid canals and the lower part of the pterygopalatine canal to see the passage of the nerves through them.

Internal Maxillary Artery.— The terminal portion of the artery lies in the pterygopalatine fossa and gives off the following branches :—(1) The *posterior superior alveolar artery* (posterior dental artery) which descends along the infratemporal surface of the maxillary bone and sends twigs through the alveolar canals to supply the molar and premolar teeth and the lining of the maxillary sinus. Some twigs pass forwards to supply the gums. (2) The *infra-*

orbital artery which passes forwards to the orbit through the inferior orbital fissure. It accompanies the infra-orbital nerve and appears on the face through the infra-orbital foramen. (3) The *descending palatine artery* descends through the pterygopalatine canal with the anterior palatine nerve and gives off smaller palatine arteries which accompany the middle and posterior palatine nerves to the soft palate and palatine tonsil. The remaining portion of the artery is called the *great palatine artery* which emerges from the greater palatine foramen and passes forwards to the incisive foramen through which it ascends to anastomose with the terminal part of the nasopalatine artery. Its branches are distributed to the gums, mucous membrane and glands of the palate. (4) The *artery of the pterygoid canal* (Vidian artery) passes backwards in company with the nerve of the same name, through the pterygoid canal and supplies the mucous membrane of the nasal part of pharynx and the auditory tube. (4) The *pharyngeal artery* passes backwards through the pharyngeal canal and is distributed like the preceding artery. (5) The *sphenopalatine artery* passes medialwards and enters the nasal cavity through the sphenopalatine foramen. Its course in the nasal cavity has been examined (p. 409).

THE TONGUE.

The tongue is a muscular organ, covered by mucous membrane and is placed on the floor of the mouth. The following parts of the tongue should be identified : (1) the *body* which forms the bulk of the organ. (2) The *base* or root which forms the posterior end of the organ and is attached to the hyoid bone. (3) The *dorsum* or upper surface is divided into two symmetrical halves by a median groove which terminates posteriorly in a pit called the

foramen cæcum. From this foramen a V-shaped sulcus extends forwards and lateralwards to the margins of the tongue. This is called the *sulcus terminalis*. (4) The *apex* or tip is the free anterior extremity. (5) The *lower surface* is seen on turning up the apex. (6) The *lateral margins* are rounded and separate the upper from the lower surface.

The *mucous membrane* of the tongue covers the whole of the organ. On the lower surface of the tongue it forms in the middle line a fold, the *frenulum linguæ*, which connects the organ to the floor of the mouth. On either side of the frenulum is a fold of mucous membrane, called the *plica fimbriata*, which extends anteroposteriorly. From the free margin of the plica a series of fringe-like processes project. These small projections, called the papillæ of the tongue, are thickly distributed in the mucous membrane covering the dorsum of the tongue in front of the sulcus terminalis. Behind the sulcus terminalis the mucous membrane presents small lymphoid nodules and is continued on to the epiglottis being raised into a fold called the *glosso-epiglottic fold*.

Papillæ of the Tongue.—These are of four kinds, viz., vallate, fungiform, conical and filiform. The *papillæ vallatæ* (circumvallate), eight to twelve in number, are of large size and are arranged at the back part of the dorsum of the tongue like the limbs of the letter V in front of the sulcus terminalis. The free end of each papilla is broad, while the attached end is narrow and lies at the bottom of a circular depression. This depression is surrounded by a slightly raised wall called the *vallum*. The *papillæ fungiformes* are smaller but more numerous than the papillæ vallatæ. They are found chiefly on the sides and tip of the tongue and sparingly over its dorsum. Each papilla has a rounded head and is

distinguished during life by its bright red colour. The *papillæ conicæ* are smaller than the preceding but more numerous. They are small conical processes with pointed ends and are arranged in lines parallel to those of the papillæ vallatæ, except at the tip of the organ where they are arranged in more or less transverse columns. The *papillæ filiformes* are conical papillæ whose apices have been broken up into thread-like projections.

Muscles of the Tongue.—The substance of the tongue is composed of muscle fibres and some fatty tissue. In the median plane between the two halves of the tongue a fibrous septum is interposed. Each half is composed of two sets of muscles, extrinsic and intrinsic. The *extrinsic muscles* are inserted into the tongue having their origins outside the organ. These are the styloglossus, the glossopalatinus, the hyoglossus, the genioglossus and the chondroglossus. They have been already examined except the chondroglossus. The *intrinsic muscles* are entirely limited to the organ itself. They are the longitudinalis superior, the longitudinalis inferior, the transversus linguæ and the verticalis linguæ.

The *chondroglossus* arises from the medial aspect of the base of the lesser cornu and the contiguous part of the body of the hyoid bone. It passes upwards and blends with the intrinsic muscles of the tongue. It is separated from the hyoglossus by some fibres of the genioglossus.

The *longitudinalis superior* lies longitudinally along the entire dorsal surface of the tongue immediately beneath the mucous membrane which should be removed to expose it. The *longitudinalis inferior* lies on the undersurface of the tongue being placed between the hyoglossus and the genioglossus. It extends from the root of the organ to its tip where it blends with the styloglossus. The *transversus linguæ* will be seen by making a coronal section of the tongue. The transverse fibres composing

it extend from the median septum transversely to the margins of the tongue. The *verticalis linguæ* will be seen in the same section. The fibres composing it run from the dorsum to the lower surface of the organ decussating with the transverse fibres.

The **Nerves of the Tongue** are (1) the hypoglossal which is the motor nerve of the tongue (p. 359); (2) the lingual which is the nerve of general sensibility for the anterior two-thirds of the organ ; (3) the glossopharyngeal nerve which is the nerve of taste and general sensibility ; (4) the internal laryngeal nerve which supplies the mucous membrane at the base of the tongue in front of the epiglottis. All these nerves should now be traced further through the substance of the organ to their terminations.

THE LARYNX.

The larynx is the upper dilated portion of the wind-pipe in which voice is produced. In front it is covered by the fascia colli, the sternohyoideus, sternothyreoideus, the thyreohyoideus, superior belly of the omohyoideus and the pyramidal process of the thyreoid gland. On each side it has the great vessels of the neck and the lateral lobe of the thyreoid gland. Behind it is the pharynx. Below it is continuous with the trachea. Above it communicates with the pharynx by an opening called the entrance into the larynx.

The *entrance into the larynx* (*aditus laryngis*) is somewhat triangular in shape, being broad in front and narrow behind. It slopes rapidly from above downwards and backwards. In front it is bounded by the epiglottis, laterally by the aryepiglottic folds and behind by the apices of the arytænoid cartilages and the corniculate cartilages.

The intrinsic muscles and ligaments of the larynx

should now be examined. Remove the thyreoid gland and also the extrinsic muscles of the larynx, viz., the sternohyoideus, the sternothyreoideus, the thyreohyoideus and the inferior constrictor of the pharynx. Preserve the external and internal laryngeal nerves, the recurrent nerve and the superior and inferior laryngeal vessels.

The **Hyothyreoid Membrane** is a fibro-elastic structure connecting the hyoid bone to the thyreoid cartilage. It consists of a central portion and two rounded lateral

Fig. 79.—Sideview of the larynx; one lamina of the thyreoid cartilage partially removed, the lower part being turned down (Sappey).

A. Greater cornu of hyoid.
B. Lesser cornu of hyoid.
C. Cartilago triticea, in lateral hyothyreoid ligament.
D. Body of hyoid.
E. Hyothyreoid membrane.
F. Epiglottis.
G. Superior cornu of thyreoid cartilage.
H. Front of hyothyreoid membrane.
I. Corniculate cartilage.
J. Aryepiglotticus.
K. Arytænoideus.
L. Thyreoid cartilage.
M. Lateral angle of base of arytænoid cartilage.
N. Thyreoarytænoideus.
O. Cricoarytænoideus posterior.
P. Cricoarytænoideus lateralis.
Q. Articulation between inferior cornu of thyreoid and cricoid (laid open).
R. Cricothyreoideus (turned down).
S. Cricoid cartilage.
T. Lower part of right lamina of thyreoid cartilage turned down.
U. Trachea.

portions called the lateral hyothyreoid ligaments. The central portion is attached above to the posterior margin of the upper border of the body and greater cornu of the hyoid bone and below to the upper border of the thyreoid cartilage, a mucous bursa being interposed between the

posterior surface of the body of the hyoid bone and the membrane. The central portion of the membrane is thicker in the middle than at the sides. This thickened portion is called the *middle hyothyreoid ligament.* The thinner lateral portion is perforated by the superior laryngeal vessels and the internal laryngeal nerve. The *lateral hyothyreoid ligaments* are two rounded cords each of which extends from the tip of the greater cornu of the hyoid bone to the superior cornu of the thyreoid cartilage. They contain usually a small cartilaginous nodule called the *cartilago triticea.*

The **Cricothyreoideus** arises from the front and side of the arch of the cricoid cartilage. It is divisible into two portions an anterior and a posterior. The anterior or *oblique portion* consists of fibres which pass upwards and backwards to be inserted into the back part of the lower border of the thyreoid cartilage. The posterior or *straight portion* consists of fibres which pass backwards and lateralwards to be inserted into the anterior border of the inferior cornu of the thyreoid cartilage. Between the anterior borders of the two muscles is seen the middle cricothyreoid ligament. The external laryngeal nerve supplies this muscle.

The cricothyreoid muscle overlapping the lateral portion of the conus elasticus is now to be removed.

The **Conus Elasticus** (cricothyreoid membrane) consists of an anterior triangular portion and two lateral portions. The anterior portion or *middle cricothyreoid ligament* is thick and is attached below by its broad end to the upper border of the anterior part of the cricoid arch and above by its narrow end to the front part of the lower border of the thyreoid cartilage. The *lateral portions* extend from the superior border of the cricoid cartilage beneath the mucous membrane of the larynx to the inferior margins of the vocal ligaments.

To expose the cricoarytænoideus posterior and the arytænoideus the mucous membrane covering the posterior surfaces of the cricoid and arytænoid cartilages is to be removed. The mucous membrane of the aryepiglottic fold is also to be removed from the lateral aspect to expose the aryepiglottic muscle.

The **Cricoarytænoideus Posterior** arises from the depression on the posterior surface of the quadrilateral portion of the cricoid cartilage. From this origin the fibres

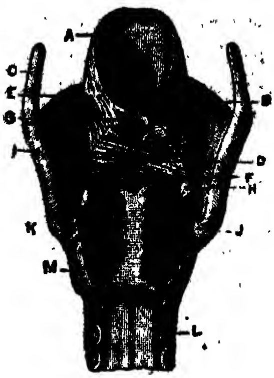


Fig. 80.—Posterior view of larynx (Sappey).

A. Epiglottis.
B. Aryepiglotticus.
C. Superior cornu of thyreoid cartilage.
D. Arytænoideus obliquus.
E. Aryepiglottic fold.
F. Arytænoideus transversus.
G. Tip of arytænoid cartilage.
H. Lateral angle of base of arytænoid cartilage.
I. Thyreoid cartilage.
J. Crico-arytænoideus posterior.
K. Articulation between inferior cornu of thyreoid and cricoid.
L. Trachea.
M. Back of cricoid cartilage.

converge to be inserted into the back part of the muscular process of the arytænoid cartilage.

The **Arytænoideus** extends between the posterior surfaces of the arytænoid cartilages. It consists of two portions, an oblique and a transverse. The *arytænoideus obliquus* is superficial and consists of two bundles of fibres. Each bundle passes from the back part of the muscular process of the arytænoid cartilage obliquely upwards to the apex of the opposite arytænoid cartilage. These two bundles cross each other along the middle line like the limbs of the letter X. From the apices of the arytæ-

noid cartilages some fibres are prolonged to the margins of the epiglottis along the aryepiglottic folds forming *aryepiglotticus muscles*. The *arytænoideus transversus* consists of transverse fibres lying beneath the oblique muscle. The fibres extend from the posterior surface and lateral border of one arytænoid cartilage to the corresponding parts of the other cartilage.

Open up the larynx from behind by cutting with scissors vertically along the middle line through the interval between the two arytænoid cartilages and the quadrilateral portion of the cricoid cartilage.

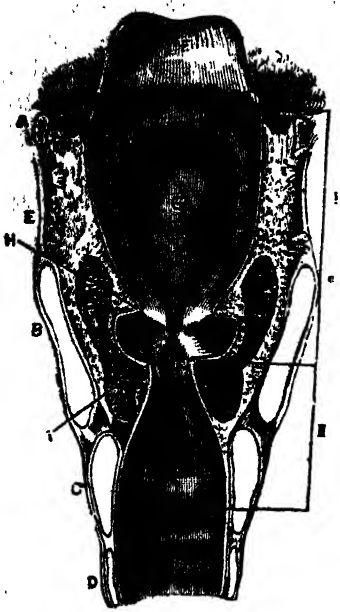


Fig. 81.—The cavity of the larynx (Luschka).

A. Hyoid bone.
B. Thyreoid cartilage.
C. Cricoid cartilage.
D. First tracheal ring.
E. Hyothyreoid membrane.
F. Epiglottis.
G. Tubercle or cushion of epiglottis.
H. Ventricular fold.
I. Vocal fold.

The *mucous membrane* of the larynx on either side presents two more or less crescentic folds, an upper and a lower, running from before backwards. The upper one is called the ventricular fold and the lower one, the vocal fold. The *ventricular fold* (false vocal cord) encloses a fibrous band, called the ventricular ligament, and will

be examined later. Its free crescentic margin is directed downwards. The *vocal fold* (true vocal cord) produces voice by its vibrations. It enclosses an elastic ligamentous band, called the *vocal ligament* and the musculus vocalis lies lateral to it. It extends from the processus vocalis of the arytænoid cartilage to the angle of the thyreoid cartilage. Its upper free margin forms the lower boundary of the ventricle of the larynx.

The *ventricle of the larynx* is the fossa in each lateral wall of the larynx lying between the ventricular fold above and the vocal fold below. Lateral to it is the lamina of the thyreoid cartilage lined by mucous membrane. From the anterior end of the fossa a diverticulum passes upwards lateral to the anterior end of the ventricular fold. This pouch is called the *appendix of the laryngeal ventricle* (laryngeal saccule).

The **Cavity of the Larynx** is divided into two portions, an upper and a lower, by the projections of the vocal folds. The upper portion lies above the level of these folds and is called the *vestibule*. The vestibule is broad above and narrow below and presents in its anterior wall an elevation caused by the tubercle of the epiglottis. The lower portion is narrow and elliptical above but broad and circular below where it is continuous with the trachea. The narrow chink or fissure between the vocal folds by which the vestibule communicates with the lower portion of the larynx is called the *rima glottidis*.

The *rima glottidis* is bounded on either side by the vocal folds in front and the medial aspects of the bases and vocal processes of the arytænoid cartilages behind. Posteriorly it is limited by the mucous membrane passing between the arytænoid cartilages. The front portion of it lying between the vocal folds is called the *intermembranous portion* (glottis vocalis) and the hind portion of it

lying between the arytænoid cartilages is called the *intercartilaginous portion* (glottis respiratoria).

To expose the remaining intrinsic muscles of the larynx, the right lateral portion of the hyothyreoid membrane and the conus elasticus are to be divided. The right inferior cornu of the thyreoid cartilage is to be disarticulated from the cricoid cartilage and the right lamina of the thyreoid cartilage is to be divided a little to the right side of the middle line. Reflect this loose piece of the right lamina of the thyreoid cartilage forwards detaching he muscles and mucous membrane from its inner surface.

The **Cricoarytænoideus Lateralis** arises from the back part of the upper border of the arch of the cricoid cartilage. The fibres pass upwards and backwards to be inserted into the front aspect of the muscular process of the arytænoid cartilage.

The **Thyreoarytænoideus** arises from the lower half of the angle of the thyreoid cartilage and from the middle cricothyreoid ligament and is inserted into the base and antero-lateral surface of the arytænoid cartilage.

Remove the superficial fibres of the thyreoarytænoideus. The musculus vocalis is exposed.

The **Musculus Vocalis** lies deep to the lower fibres of the thyreoarytænoideus and extends from the angle of the thyreoid cartilage to the muscular process and the adjoining antero-lateral surface of the arytænoid cartilage. Some of its fibres are inserted into the vocal ligament which lies parallel to its medial surface.

The **Thyreoepiglotticus** arises from the angle of the thyreoid cartilage above the attachment of the musculus vocalis. It passes upwards and backwards to the aryepiglottic fold and is inserted into the side of the epiglottis at its lower part.

Remove the musculus vocalis and the thyreoepiglottic

muscle. The vocal and ventricular ligaments and the outer surface of the conus elasticus are exposed.

The *vocal ligament* is a thickened band of elastic tissue enclosed between the two layers of the vocal fold. It is attached in front to the angle of the thyreoid cartilage and behind to the muscular process of the arytænoid cartilage. Below it is continuous with the lateral portion of the conus elasticus. The musculus vocalis lies lateral and parallel to it.

The *ventricular ligament* is a band of fibrous tissue enclosed between the two layers of the ventricular fold. It is attached in front to the angle of the thyreoid cartilage below the attachment of the epiglottis. Behind it is attached to the antero-lateral surface of the arytænoid cartilage above the attachment of the vocal ligament.

Nerves of the Larynx.—These are :—(1) the *internal laryngeal branch* of the superior laryngeal nerve which pierces the lateral portion of the hyothyreoid membrane and breaks up into three branches. The upper branch supplies the mucous membrane lining the epiglottis and the aryepiglottic fold ; the middle branch supplies the mucous membrane over the side wall of the larynx ; and the lower branch descends beneath the mucous membrane lining the lamina of the thyreoid cartilage to communicate with the recurrent nerve. (2) The *external laryngeal branch* of the superior laryngeal nerve supplies the cricothyreoid muscle. (3) The *recurrent nerve* enters the interior of the larynx as the inferior laryngeal nerve behind the articulation between the inferior cornu of the thyreoid cartilage and the cricoid cartilage. It communicates with the lower branch of the internal laryngeal nerve and divides into branches which supply all the muscles of the larynx except the cricothyroideus. It also supplies the mucous membrane below the vocal folds.

The **Vessels of the Larynx** are :—(1) The *superior laryngeal artery* which is a branch of the superior thyreoid artery and accompanies the internal laryngeal branch of the superior laryngeal nerve to the interior of the larynx. (2) The *inferior laryngeal artery* which is a branch of the inferior thyreoid artery. It accompanies the inferior laryngeal nerve to the interior of the larynx and supplies its mucous membrane and muscles.

The mucous membrane and the muscles are now to be removed from the left side to expose the cartilages of the larynx and to define the ligaments binding them together. The corniculate cartilages surmounting the apices of the arytænoid cartilages should be defined and the cuneiform cartilages contained in the aryepiglottic folds should be secured. Before removing the mucous membrane covering the anterior surface of the epiglottis note that it is reflected on to the base and margins of the tongue forming the *middle* and *lateral glossoepiglottic folds*. The depression between the base of the tongue and the epiglottis on each side of the middle glossoepiglottic fold is called the *vallecula.*

The **Epiglottis** is a piece of yellow fibrocartilage which lies behind the tongue and projects over the superior aperture of the larynx like a valve. It is like an ovoid leaf in shape with its narrow end attached by the thyreoepiglottic ligament to the angle formed by the two laminæ of the thyreoid cartilage. Its broad end is rounded and free. The anterior surface at its upper part is covered by mucous membrane which is reflected on to the tongue. Lower down the anterior surface is connected to the hyoid bone by the hyoepiglottic ligament. The posterior surface is concave from side to side and concavo-convex from above down. The lower part of this surface presents a projection called the *tubercle* or *cushion.* To its sides are attached the aryepiglottic folds.

The epiglottic ligaments are :—(1) the median and lateral glossoepiglottic folds, (2) the hyoepiglottic ligament, and (3) the thyreoepiglottic ligament. These have been described.

The **Thyreoid Cartilage** consists of two lateral plates called the *laminæ* which unite at an acute angle in front forming a projection in the middle line of the neck called the *laryngeal prominence* (pomum Adami). This prominence is more marked in males. Each lamina is quadrilateral in form, presenting for examination four borders and two surfaces. The *superior border* is convex in general and affords attachment to the hyothyreoid membrane. At the junction of the two laminæ at the superior border is a V-shaped notch called the *superior thyreoid notch*. The *inferior border* is slightly concave and gives attachment anteriorly to the middle cricothyreoid ligament and posteriorly to the cricothyreoid muscle. A little behind the mid-point of this border is a tubercle called the *inferior tubercle*. The *anterior border* is fused with that of the other lamina in the middle line. The *posterior border* is thick and rounded and is prolonged above and below as the cornua. The *superior cornu* is long and gives attachment to the lateral hyothyreoid ligament. The *inferior cornu* is short and has a facet on the medial side of its tip which articulates with the side of the cricoid cartilage. The *lateral surface* of each lamina presents in front of the root of the superior cornu a tubercle called the *superior tubercle*. From this tubercle a ridge runs downwards and forwards to the inferior tubercle. The ridge gives attachment to the sternothyreoid and the thyreohyoid muscles and the portion of cartilage behind it to the inferior constrictor of the pharynx. The *inner surface* of each lamina is slightly concave and is covered by mucous membrane. To the angle in front are attached the thyreoepiglottic ligament, the ventricular and vocal

ligaments and thyreoarytænoid and thyreoepiglottic muscles.

The hyothyreoid ligament connecting the thyreoid cartilage to the hyoid bone has been already described.

The **Cricoid Cartilage** resembles a signet ring in shape. It consists of two portions, a quadrilateral part situated behind called the lamina and a narrow arch placed in front called the arch of the cricoid. The *lamina* is about an inch in length from above downwards and presents on its posterior surface a median vertical ridge to which the longitudinal muscle fibres of the œsophagus are attached. On either side of this ridge is a depression for the origin of the cricoarytænoideus posterior. The *arch* of the cricoid cartilage measures about a quarter of an inch vertically, and gives attachment by its outer surface to the cricothyreoidei in front and at the sides and to the inferior constrictor of the pharynx behind. At the junction of the lamina with the arch there is a small circular facet on the outer surface for articulation with the inferior cornu of the thyreoid cartilage. The *superior border* of the cricoid cartilage slopes downwards and forwards over the arch and affords attachment in front and at the sides to the conus elasticus. Posteriorly it presents in the middle a notch and on either side of this an oval convex facet for articulation with the base of the arytænoid cartilage. The inferior border is horizontal and is connected to the first ring of the trachea by the cricotracheal ligament.

The *ligaments* connecting the thyreoid and cricoid cartilages are :—(1) the conus elasticus which has been already examined. (2) An articular capsule which surrounds the articulation between the inferior cornu of the thyreoid cartilage and the lateral surface of the cricoid cartilage. The capsule is lined by a synovial stratum.

The Arytænoid Cartilages, two in number, are pyra-

midal in shape and surmount the lamina of the cricoid cartilage. Each cartilage presents for examination three surfaces, a base and an apex. The *posterior surface* is concave and gives attachment to the arytænoideus. The *anterolateral surface* is rough and gives attachment to the ventricular ligament and to the vocalis and thyreoarytænoid muscles. The *medial surface* is smooth and flat and covered by mucous membrane. The *base* is concave and presents an articular facet for the cricoid cartilage. It presents two prominent angles. The anterior angle or *vocal process* projects forwards and gives attachment to the vocal ligament. The lateral angle or *muscular process* projects backwards and lateralwards and gives attachment to the cricoarytænoideus lateralis in front and the cricoarytænoideus posterior behind. The *apex* is directed upwards, backwards and medialwards and is surmounted by the corniculate cartilage.

The *ligaments* connecting the arytænoid cartilage with the cricoid are : (1) an articular capsule which surrounds the articular surfaces at the base of the arytænoid cartilage and the superior border of the lamina of the cricoid cartilage ; it is lined by a synovial stratum. (2) The conus elasticus which connects the two cartilages.

The **Corniculate Cartilages** (cartilages of Santorini) are two small conical cartilaginous nodules which articulate with the summits of the arytænoid cartilages.

The **Cuneiform Cartilages** (cartilages of Wrisberg) are two elongated cylindrical nodules of elastic cartilage, placed one on each side, in the aryepiglottic fold.

THE EAR.

The ear or organ of hearing is divisible into three portions : the external ear, the middle ear, and the internal ear. The external ear consists of the pinna and the

external acoustic meatus. The pinna has been described (p. 295).

To study the external acoustic meatus the following dissection is necessary. Remove the soft parts attached to the temporal bone. Clean the cartilaginous portion of the auditory tube and disarticulate the petrous portion of the temporal bone from the sphenoid. Remove the squamous portion of the temporal bone by a saw-cut passing in front of the petrotympanic fissure. Cut away with bone forceps the anterior wall of the external acoustic meatus till the membrana tympani at the bottom of the meatus is clearly seen.

The **External Acoustic Meatus** (External auditory meatus) is about an inch in length and is directed forwards and medialwards from the bottom of the concha. In its course it presents a curve the convexity of which is directed upwards. The medial two-thirds of the canal is bony whereas the lateral third is cartilaginous. The deficiency in the cartilaginous wall at the upper and back part has been noted. The bony portion of the canal is narrower than the cartilaginous portion and the narrowest part of the canal, called the *isthmus*, is seen about one-fifth of an inch lateral to the membrana tympani. The medial end of the canal is closed by the membrana tympani which is placed obliquely in such a way that the anterior wall and the floor of the canal are longer than the posterior wall and the roof. The skin lining the external acoustic meatus is prolonged over the lateral surface of the membrana tympani as a thin cuticular layer. In the cartilaginous portion of the canal the skin is covered with hair.

The **Membrana Tympani** is an oval membrane forming the medial boundary of the external acoustic meatus and placed obliquely from above downwards and forwards so as to form an acute angle with the floor of the canal.

Its lateral surface is concave and the deepest part of the concavity is called the *umbo*. The handle of the malleus descends through the membrane and shines through it. The tip of the handle lies opposite the umbo. The circumference of the membrane is fixed to the *sulcus tympanicus* except at the upper part where a gap exists in the sulcus called the *incisura tympanica* (notch of Rivinus). From the anterior and posterior ends of this notch two thickened folds, called the *anterior* and *posterior malleolar folds*, converge to the lateral process of the malleus projecting a little below the notch. The triangular piece of the membrana tympani included between the anterior and posterior malleolar folds and the incisura tympanica is loose and hence called the *membrana flaccida*.

The tympanic cavity should now be opened from above. The whole of the tegmen tympani forming the roof of the tympanic cavity and lying lateral to the eminentia arcuata on the anterior surface of the petrous portion of the temporal bone is to be removed with chisel and bone forceps. When the tympanic cavity has been fully exposed open up the canal for the tensor tympani muscle in front and the tympanic antrum behind.

The **Tympanic Cavity** or **Middle Ear** is a small air-chamber placed between the membrana tympani and the internal ear. Its vertical and antero-posterior diameters are each about half an inch. Its transverse diameter is about a sixth of an inch. It is traversed by a chain of bones which extend from its lateral to its medial wall. It is lined by mucous membrane which is continuous with that of the pharynx through the auditory tube. The cavity is divisible into two parts, an upper part lying above the level of the membrana tympani, called the *attic* or *epitympanic recess*, and a lower part called the

tympanic cavity proper which corresponds to the depth of the membrana tympani.

Boundaries.—The tympanic cavity presents for examination a roof, a floor, and four walls. The *roof* is formed by a thin plate of bone, called the *tegmen tympani*, which has been removed. The *floor* or *jugular wall* is formed by a thin plate of bone which separates the tympanic cavity from the jugular fossa. The *anterior* or *carotid wall* is formed by a lamina of bone which lies between the tympanic cavity and the carotid canal. At its upper part is seen the orifice of the semicanal for the tensor tympani muscle and below that the orifice of the auditory tube. These two orifices are separated from each other by a thin lamina of bone called the *septum canalis musculo-tubarii*. The *posterior* or *mastoid wall* presents at its upper and lateral part an opening which leads into the mastoid antrum and below this a hollow conical eminence called the *pyramid*. The pyramid contains the stapedius muscle and its summit is perforated by a small aperture for the passage of the tendon of the muscle. At the posterior wall at its junction with the lateral wall there is a minute aperture at the upper part, called the *iter chordæ posterius* through which the chorda tympani nerve enters the tympanic cavity. The *lateral wall* is formed chiefly by the tympanic membrane and the grooved ring of bone to which it is fixed. The *medial* or *labyrinthic wall* is formed by the lateral wall of the labyrinth. This wall presents for examination :—(1) A rounded eminence in front called the *promontory* caused by the first turn of the cochlea. (2) An oval opening placed above the promontory called the *fenestra vestibuli* (fenestra ovalis) which leads into the vestibule of the internal ear and is closed in the recent state by the stapes. (3) Another opening, called the *fenestra cochleæ*, is situated below and behind the promontory and is closed in the recent state

by a membrane called the *secondary tympanic membrane.* (4) The *eminence of the facial canal* (aquæductus Fallopii)

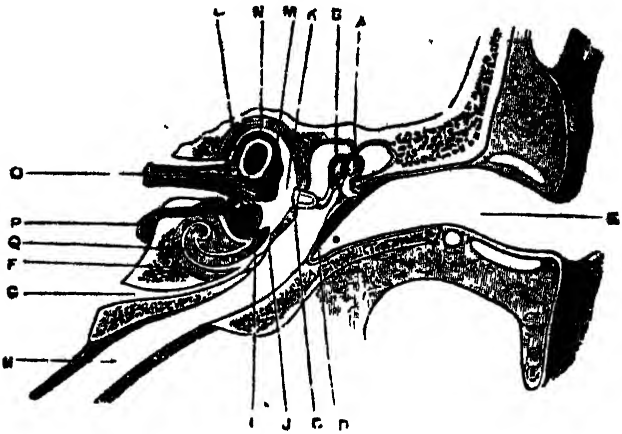


Fig. 82.—Diagram of the auditory apparatus (after Poirier).

A. Malleus.
B. Incus.
C. Stapes.
D. Membrana tympani.
E. External acoustic meatus.
F. Cochlea.
G. Aqueductus cochleæ.
H. Auditory tube.
I. Scala tympani.
J. Fenestra cochlearis.
K. Perilymph in vestibule.
L. Saccule.
M. Utricle.
N. Superior semicircular canal.
O. Acoustic nerve.
P. Saccus endolymphaticus.
Q. Cochlear canal.

extends along the medial wall from before backwards above the fenestra vestibuli.

The **Tympanic Antrum** is the cavity which communicates in front with the epitympanic recess of the tympanic cavity. It is bounded above by the tegmen tympani; laterally by the squamous portion of the temporal bone below the temporal line; medially by the petrous part of the temporal bone in which is seen an eminence caused

by the lateral semicircular canal; below and behind by the mastoid portion of the temporal bone in which are seen apertures which communicate with the mastoid air cells.

The Contents of the Middle Ear are (1) the auditory ossicles, (2) the ligaments of the ossicles, (3) the muscles of the tympanic cavity, and (4) the nerves seen in the tympanic cavity.

The **Auditory Ossicles** are three in number, viz., malleus, incus and stapes.

The *malleus* consists of a head, a neck, and three processes, called the manubrium, the anterior and lateral processes. The *head* projects into the epitympanic recess and articulates by its posterior aspect with the incus. The articular surface is constricted in the middle. The *neck* is the constricted portion below the head. The *manubrium* is embedded throughout its entire length in the membrana tympani. The *anterior process* (processus gracilis) projects forwards from below the neck and is received into the petrotympanic fissure. The *lateral process* (processus brevis) projects lateralwards from the root of the manubrium and rests against the tympanic membrane at the apex of the membrana flaccida.

The *incus* consists of a body and two crura, short and long. The *body* articulates in front with the head of the malleus. The *short crus* passes almost horizontally backwards and lies against the posterior wall of the tympanum to which it is held by a ligament. The *long crus* descends vertically and at its lower end is bent medialwards terminating in a rounded knob, called the *lenticular process*, which articulates medially with the head of the stapes.

The *stapes* resembles a stirrup and presents a head, neck, two crura, and a base. The *head* presents a concave fact laterally for articulation with the lenticular process

of the incus. The *neck* is the constricted part between the head and the crura and to it is inserted the stapedius muscle. Of the two crura the anterior is shorter and less curved than the posterior. The *base* is an oval plate of bone which connects the crura and is received in the fenestra vestibuli; to the margin of which it is attached by an annular ligament. The upper margin of the base is convex and the lower almost straight.

The **Ligaments of the Ossicles** :—There are two *articular capsules;* one surrounds the articulation between the head of the malleus and the body of the incus; the other surrounds the articulation between the head of the stapes and the lenticular process of the incus. The malleus is connected with the wall of the tympanic cavity by three ligaments. (1) The *anterior ligament of the malleus* connects its anterior process to the petrotympanic fissure. (2) The *lateral ligament of the malleus* connects its lateral process to the incisura tympanica. (3) The *superior ligament of the malleus* connects the head of the malleus to the roof of the tympanum. The incus is connected to the tympanic wall by the *ligament of the incus* which fixes its short process to the posterior wall of the tympanic cavity. The *annular ligament of the stapes* connects the circumference of the base of the stapes to the margin of the fenestra vestibuli.

The **Muscles of the tympanic cavity** are two in number, the tensor tympani and the stapedius.

The *tensor tympani* arises from the cartilaginous portion of the auditory tube, from the adjoining part of the sphenoid and from the wall of the bony canal containing it. It passes backwards and lateralwards through the canal for it above the bony part of the auditory tube. Entering the tympanic cavity its tendon turns abruptly lateralwards to be inserted into the medial aspect of the

manubrium of the malleus near its root. It is supplied by a branch from the otic ganglion.

The *stapedius* arises from the interior of the pyramid. Its tendon emerges from an aperture on the summit of the pyramid and is inserted into the posterior aspect of the neck of the stapes. It is supplied by a branch of the facial nerve.

The **mucous membrane** of the tympanic cavity lines the ossicles, ligaments and muscles and is continuous with that of the pharynx through the auditory tube. It lines the medial surface of the membrana tympani.

The course of the *chorda tympani nerve* through the tympanic cavity should be noted. It enters the tympanic cavity through the iter chordæ posterior in the posterior wall near the upper end of the membrana tympani. Then it traverses the membrana tympani through which it shines lying between its fibrous layer and mucous lining at the level of the upper end of the manubrium. It issues out of the cavity through the iter chordæ anterior (canal of Huguier) at the medial end of the petrotympanic fissure.

The *tympanic plexus* ramifies upon the promontory on the medial wall of the tympanic cavity. It is formed by the tympanic branch of the glossopharyngeal nerve communicating with superior and inferior carotico tympanic branches of the internal carotid plexus of the sympathetic. Its branches supply the mucous lining of the cavity.

The facial nerve should now be exposed in the facial canal. Remove the auditory ossicles. Remove the lateral wall of the tympanic cavity with bone forceps. Then by a horizontal saw cut remove a slice of bone immediately above the level of the root of the internal acoustic meatus. Then with bone forceps remove the thin layer of bone still forming the roof of the meatus.

The facial nerve is now exposed at its point of entrance into the facial canal. Open up the facial canal commencing from the bottom of the internal acoustic meatus. Trace the facial nerve lateralwards in the canal up to the hiatus canalis facialis (which also has to be opened up); then backwards along the medial wall of the tympanic cavity; and follow it downwards along the posterior wall to its exit from the stylomastoid foramen. If the student can have the temporal bone softened in dilute acid solution the whole of the facial canal can be easily opened up by cutting with the knife. The lateral wall of the tympanic cavity need not be removed, but the upper part of the bony ring to which the tympanic membrane is attached should be bent laterally.

Facial Nerve in the Temporal Bone.—In the internal acoustic meatus the facial nerve consisting of its motor and sensory roots passes above and anterior to the acoustic nerve; the sensory root lying between the motor root and the acoustic nerve. The two roots join and the trunk then enters the facial canal at the bottom of the meatus. In the facial canal the nerve at first runs lateralwards over the vestibule between the cochlea in front and the semicircular canals behind and presents a swelling called the *genicular ganglion.* At the ganglion the nerve bends backwards abruptly and passes along the upper part of the medial wall of the tympanic cavity. Reaching the posterior wall of the middle ear the nerve descends almost vertically to its point of exit from the stylomastoid foramen.

The *branches* of the facial nerve in the facial canal are: (1) the *greater superficial petrosal nerve* which arises from the genicular ganglion and passes through the hiatus of the facial canal. Its subsequent course has been described (p. 244). (2) *Communicating filament* to the lesser superficial petrosal nerve which arises from the

genicular ganglion. (3) The *external petrosal nerve* is a minute filament which arises from the genicular ganglion and joins the sympathetic plexus around the middle meningeal artery. (4) The *nerve to the stapedius* muscle arises from the facial nerve when it passes through the facial canal behind the pyramid. (5) The *communicating filament* to the auricular branch of the vagus arises below the origin of the nerve to the stapedius muscle. (6) The *chorda tympani nerve* carries the sensory fibres of the facial nerve and arises a little above the termination of the parent trunk in the facial canal. Its course along the membrana tympani has been examined.

The **Acoustic Nerve** lies below and behind the facial nerve in the internal acoustic meatus. At the bottom of the meatus it divides into two divisions, the cochlear and the vestibular. Filaments from these enter the minute apertures in the lamina cribrosa for distribution to the different parts of the internal ear.

The bony labyrinth consists of the cochlea in front, the vestibule in the middle and the semicircular canals behind. Locate the positions of these parts and with a chisel define the bony labyrinth.

The **Internal Ear** or **Labyrinth** consists of two parts, (1) the osseous labyrinth, being a series of cavities hollowed out of the petrous portion of the temporal bone, which intercommunicate with each other and are called the vestibule, semicircular canals, and cochlea; and (2) the membranous labyrinth consisting of membranous channels contained within the osseous labyrinth.

The **Vestibule** is the central chamber of the bony labyrinth, being situated behind the cochlea and in front of the semicircular canals. On its *lateral wall* is seen the fenestra vestibuli which is closed in the recent state by the base of the stapes. Its *medial wall* corresponds to the bottom of the internal acoustic meatus and presents

in front a circular depression, the *recessus sphæricus*, which lodges the saccule and is perforated by minute apertures for the passage of filaments from the acoustic nerve to the saccule. Behind this circular depression is an oblique ridge called the *crista vestibuli*. At the back part of the medial wall is the opening of the *aquæductus vestibuli* which leads to the posterior surface of the petrous portion of the temporal bone. It lodges a diverticulum of the membranous labyrinth called the *ductus endolymphaticus*. On the *upper wall* or *roof* is an elliptical depression, called the *recessus ellipticus*, which lodges the utricle. The vestibule communicates behind with the three semicircular canals by five openings and in front with the scala vestibuli of the cochlea.

The **Bony Semicircular Canals** are three in number and named superior, posterior, and lateral. Each canal presents a dilatation at one end called the *ampulla* where it opens into the vestibule. The *superior semicircular canal* is vertically placed at right angles to the long axis of the petrous portion of the temporal bone. Its lateral end is ampullated and its medial end joins with the upper end of the posterior semicircular canal forming the *crus commune*. The *posterior semicircular canal* is also vertically placed parallel to the posterior surface of the petrous portion of the temporal bone. Its upper end joins the medial end of the superior semicircular canal forming the crus commune. Its lower end is ampullated. The *lateral semicircular canal* is horizontal and placed between the superior and posterior semicircular canals. It projects into the medial wall of the tympanic antrum. Its ampullated end is close to the ampullated end of the superior semicircular canal.

The **Cochlea** resembles somewhat the shell of a snail and is conical in shape. Its apex or *cupola* is directed forwards and lateralwards. Its *base* is directed backwards

and medialwards towards the bottom of the internal acoustic meatus and is perforated by several minute apertures for the passage of filaments of the cochlear division of the acoustic nerve. It consists of a canal wound spirally for two turns and a half around a central pillar called the *modiolus*. This canal is partially subdivided into two passages by a thin lamina of bone, termed the *lamina spiralis*, which projects from the modiolus and follows the turns of the canal. The upper passage is called the scala vestibuli and the lower one, the *scala tympani*. The lamina spiralis leaves an opening at the cupola, called the *helicotrema*, through which the scala vestibuli and scala tympani communicate with each other. The modiolus is conical in shape with its base at the internal acoustic meatus and apex at the cupola. It is perforated by minute canals for the passage of cochlear nerve filaments. One of these canals is called the *longitudinal canal of the modiolus* and traverses it from base to apex.

The **Membranous Labyrinth** is situated within the bony labyrinth. The *membranous semicircular canals* correspond exactly in contour the bony canals within which they are contained. They are separated from the bony canals by perilymph except at one place where they are attached. Within the bony vestibule there are two membranous sacs called the utricle and the saccule. The *utricle* lies behind and into it the membranous semicircular canals open. The *saccule* lies in front and communicates with the membranous cochlea by a canal called the *ductus reuniens*. The utricle and the saccule indirectly communicate with each other through the ductus endolymphaticus to which each is joined by a narrow duct. The membranous *cochlea* is called the *ductus cochlearis* (scala media). It is formed by two membranes which are attached medially to the free margin of the lamina

spiralis and laterally they diverge to become attached to the lateral wall of the bony cochlea. The upper membrane is called the *membrana vestibuli* (membrane of Reissner) and the lower one, *membrana basilaris*. Thus the separation between the scala vestibuli and scala tympani is complete. The ductus cochlearis is closed towards the apex of the cochlea and at its base communicates with the saccule by the ductus reuniens. The scala tympani communicates with the tympanic cavity through the fenestra cochlearis which is closed in the recent state by the secondary tympanic membrane.

THE ENCEPHALON OR BRAIN.

Before commencing the study of the membranes and blood vessels of the brain the student should form an idea of the general appearances presented by the organ and the arrangement of its main parts. For this he should refer to a model of the brain or if available to another brain from which the meninges and blood vessels have been removed. He should note the ovoid hemispheres of the cerebrum which on account of their large bulk cover from above the other parts of the organ. Broadly speaking each hemisphere is subdivided into four lobes, viz., the frontal lobe in front, the parietal lobe in the middle, the occipital lobe behind, and the temporal lobe below. The position of the central sulcus separating the frontal from the parietal lobe, of the parietooccipital fissure separating the parietal from the occipital lobe and of the lateral sulcus separating the frontal and parietal lobes above from the temporal lobe below should be noted. The fifth lobe or insula lies concealed in the lateral sulcus and has to be seen by drawing the

margins of the sulcus apart. The cerebral peduncles emerge from the undersurface of the cerebral hemispheres. The hind brain consists of the cerebellum lying behind, and the pons and medulla oblongata in front. The surfaces of the hemispheres are marked by elevations called gyri and indentations called fissures or sulci. The longitudinal fissure incompletely separates the two hemispheres from each other. At the bottom of this fissure a great transverse commissure is seen connecting the two hemispheres. This is called the corpus callosum. It presents anteriorly a curved end called the genu and posteriorly a thick end called the splenium. On the sides of each cerebral peduncle before it emerges from the cerebral hemisphere certain masses of grey substance are situated. Thus on its lateral side is a biconvex mass called the lentiform nucleus and on its medial side are two masses; one, called the caudate nucleus, is situated anterolaterally to the other mass called the thalamus.

Meninges of the Brain.—These are three in number, the dura mater, arachnoid and pia mater. The *dura mater* has been described (p. 227). The *arachnoid* is an exceedingly thin membrane spread over the whole surface of the brain. Unlike the pia mater it does not dip into the fissures and sulci of the brain except into the longitudinal fissure, but bridges over them. It is separated from the dura mater by a capillary space called the *subdural space* which contains fluid of the nature of lymph. It is separated from the subjacent pia mater by an interval called the *subarachnoid cavity* which contains cerebrospinal fluid and is traversed by trabeculæ of connective tissue passing from the arachnoid to the pia mater. The arachnoidean granulations which are processes of this trabecular tissue have been examined (p. 228). The subarachnoid cavity is continuous with the subarachnoid cavity of the medulla spinalis and communicates with

the ventricles of the brain as will be seen later on. Over the lateral surface of the hemispheres the subarachnoid cavity is insignificant but in certain situations at the base of the brain the arachnoid is separated from the pia mater by deep and wide intervals called subarachnoid cisternæ.

Subarachnoid Cisternæ.—These are :—(1) the *cisterna cerebellomedullaris* (cisterna magna) which is formed by the arachnoid bridging over the space between the medulla oblongata and the back part of the undersurface of the cerebellum ; (2) the *cisterna pontis* which is seen in front of the pons where the arachnoid covers the basilar artery ; (3) the *cisterna interpeduncularis* (cisterna basilis) which lies in front of the pons where the arachnoid extends from the temporal lobe of one side to that of the other ; (4) the *cisterna chiasmatis* which lies in front of the optic chiasma and contains the anterior cerebral arteries ; (5) the *cisterna fossæ cerebri lateralis* which is formed over the lateral fissures of the brain by the arachnoid bridging over the fissure between the temporal lobe, and the frontal and parietal lobes, (6) the *cisterna venæ magnæ cerebri*, which is formed by the arachnoid bridging over the gap between the posterior end of the corpus callosum and the superior surface of the cerebellum and contains the great cerebral vein.

The *pia mater* is the vascular membrane of the brain. In it the blood vessels ramify and from its deep surface minute arterial twigs enter the substance of the brain. It dips into the fissures and sulci of the cerebrum and cerebellum. On the surface of the cerebellum it is thinner and less vascular. It is prolonged into the interior of the brain forming the tela chorioidea of the third ventricle and the chorioid plexuses of the lateral and third ventricles.

The dissector should now study the arteries of the brain.

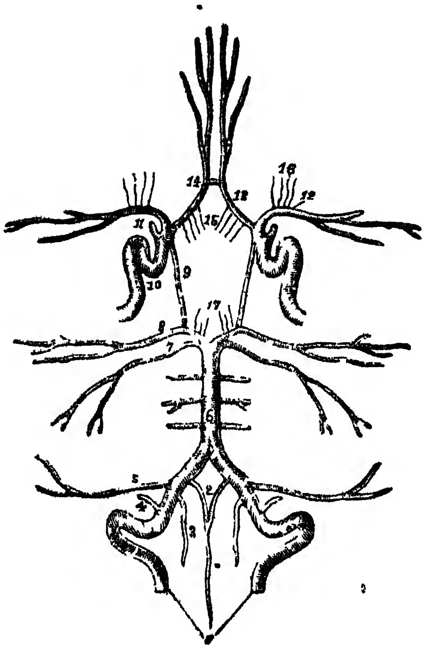
Arteries of the Brain.—These are derived from the

two internal carotid and the two vertebral arteries the branches of which form a remarkable anastomosis at the base of the brain called the circulus arteriosus.

The **Internal Carotid Artery** has been divided where it pierced the dura mater on the medial side of the anterior clinoid process (p. 241). It passes to the medial extremity of the lateral cerebral fissure where it gives off the terminal branches, viz., (1) the anterior cerebral, (2) the midlde cerebral, (3) the posterior communicating, and (4) the anterior chorioid.

The **Anterior Cerebral Artery** runs forwards and medialwards above the optic nerve to the anterior extremity of the longitudinal fissure. Here it lies side by side with the artery of the opposite side and the two vessels are connected by a short transverse branch called the anterior communicating artery. Then it proceeds forwards along the medial aspect of the frontal lobe and curving round the genu of the corpus callosum is continued backwards over the upper surface of the corpus callosum towards its splenium where it anastomoses with the posterior cerebral artery. The *branches* given off from the anterior cerebral artery are :—(1) The *antero-medial ganglionic branches* which are small twigs. They pass upwards, pierce an area of grey substance called the anterior perforated substance and supply the anterior end of the caudate nucleus, the rostrum of the corpus callosum and the septum pellucidum. (2) The *inferior frontal branches*, two or three in number, supply the medial part of the orbital surface of the frontal lobe and the olfactory tract and bulb. (3) The *anterior frontal branches* supply the anterior part of the medial surface and upper part of the lateral surface of the frontal lobe. (4) The *middle frontal branches* supply the medial surface of the frontal lobe behind the preceding branches. Its terminal twigs pass to the adjacent part of the lateral surface of the

Fig. 88.—Arteries of the brain and the arterial circle at the base of the brain (Wilson).



1. Vertebral arteries
2. Anterior spinal branches uniting to form a single vessel.
3. Posterior spinal artery.
4. Meningeal branch of vertebral artery.
5. Posterior inferior cerebellar artery.
6. Basilar artery giving off pontine branches.
7. Superior cerebellar artery.
8. Posterior cerebral artery.
9. Posterior communicating branch of internal carotid artery.
10. Internal carotid artery.
11. Ophthalmic artery.
12. Middle cerebral artery.
13. Anterior cerebral artery.
14. Anterior communicating artery.
15. Antero-medial ganglionic branches of anterior cerebral artery.
16. Antero-lateral ganglionic branches of middle cerebral artery.
17. Postero-medial ganglionic branches of posterior cerebral artery.

brain. (5) The *posterior frontal branches* supply the medial aspect of the brain in front of the parietooccipital fissure; the terminal twigs supply the adjacent part of the lateral surface of the parietal lobe.

The **Middle Cerebral Artery** proceeds along the lateral cerebral fissure at first lateralwards and then backwards and divides into terminal branches on the insula. Its *branches* are :—(1) the *antero-lateral ganglionic branches* which are numerous twigs. They pass upwards through the anterior perforated substance and supply certain grey

masses at the base called basal ganglia and the internal and external capsules. (2) The *inferior lateral frontal branches* which supply the lateral part of the orbital surface and the lower part of the lateral surface of the frontal lobe. (3) The *ascending frontal branch* which supplies the gyrus lying in front of the central sulcus. (4) The *ascending parietal branch* which supplies the gyrus behind the central sulcus. (5) The *parieto-temporal branch* which supplies the inferior part of the parietal lobe and the posterior part of the temporal lobe. (6) The *temporal branches* which curve downwards to supply the front part of the lateral surface of the temporal lobe.

The **Posterior Communicating Artery** is a slender branch which proceeds directly backwards to join the posterior cerebral artery.

The **Anterior Chorioidal Artery** passes backwards and lateralwards and enters the inferior cornu of the lateral ventricle to supply the chorioid plexus.

The **Vertebral Artery** enters the cranial cavity through

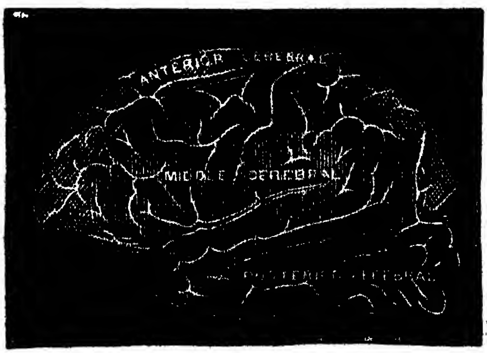


Fig. 84.—Diagram showing the distribution of cortical branches of cerebral arteries on the lateral surface of the brain.

the foramen magnum and proceeds along the side of the medulla oblongata gradually inclining towards the median line. At the lower border of the pons it unites with its fellow of the opposite side to form the basilar artery. Within the cranium it gives off the following *branches* :—(1) *Meningeal branch* which supplies the dura mater in the posterior cranial fossa. (2) The *posterior spinal artery* arises from the vertebral at the side of the medulla oblongata and passes downwards into the vertebral canal. Its course on the medulla spinalis has been described (p. 269). (3) The *posterior inferior cerebellar artery* is the largest branch of the vertebral. It proceeds backwards along the side of the medulla oblongata to the undersurface of the cerebellum and divides into two branches, a medial and a lateral. The medial branch runs backwards to the notch between the posterior ends of the cerebellar hemispheres. The lateral branch supplies the back part of the inferior surface of the cerebellar hemisphere as far as its lateral border. (4) The *anterior spinal artery* arises close to the lower border of the pons, passes downwards and medialwards on the anterior surface of the medulla oblongata and meets its fellow of the opposite side above the foramen magnum. The single trunk thus formed descends along the antero-median fissure of the medulla spinalis (p. 276). (5) The *medullary branches* are minute twigs which enter the substance of the medulla oblongata.

The **Basilar Artery** is a short vessel extending from the lower to the upper border of the pons and formed by the union of the two vertebral arteries. It runs along the median groove on the ventral surface of the pons and terminates by dividing into two posterior cerebral arteries. It gives off the following branches on each side :—(1) the *pontine branches*. These are many minute twigs which run lateralwards and supply the pons.

(2) The *internal auditory artery* which is a long slender branch; it accompanies the acoustic nerve to the internal acoustic meatus and supplies the internal ear. (3) The

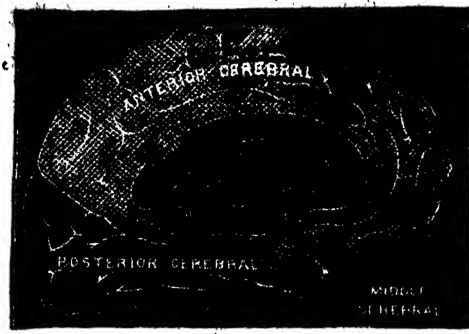


Fig. 85.—Diagram showing the distribution of cortical branches of cerebral arteries on the medial surface of the brain.

anterior inferior cerebellar artery supplies the front part of the inferior surface of the cerebellum. (4) The *superior cerebellar artery* arises from the basilar artery near its termination. It winds round the cerebral peduncle and reaches the superior surface of the cerebellum which it supplies. (5) The posterior cerebral artery.

The **Posterior Cerebral Artery** runs lateralwards being separated from the superior cerebellar artery by the oculomotor nerve. It is soon joined by the posterior communicating artery. Then it passes backwards and, winding round the peduncle of the cerebrum, reaches the undersurface of the occipital lobe close to the splenium. The *branches* of the posterior cerebral artery are :—(1) the *postero-median ganglionic branches* which are minute twigs. They arise near the origin of the parent trunk and proceed upwards. Piercing a grey area called the

posterior perforated substance they supply the thalamus. (2) The *posterior chorioidal artery* passes forwards beneath the splenium and enters the tela chorioidea of the third ventricle and the chorioid plexus of the lateral ventricle. (3) The *posterolateral ganglionic branches* are minute twigs which arise on the lateral side of the cerebral peduncle. They pass upwards to supply the thalamus. (4) The anterior and posterior *temporal branches* pass lateralwards to supply the lower surface of the temporal lobe. (5) The *calcarine branch* runs along the calcarine fissure and supplies the medial aspect of the occipital lobe. (6) The *parieto-occipital artery* runs upwards along the parieto-occipital fissure and supplies the gyri in front and behind the fissure. Its terminal branches supply the lateral surface of the occipital lobe.

Circulus Arteriosus (circle of Willis).—This important arterial anastomosis is situated in the subarachnoid cavity above the pons. It is formed *in front* by the anterior cerebral arteries connected together by the anterior communicating artery, *laterally* by the posterior communicating arteries which connect the internal carotid arteries in front with the posterior cerebral arteries behind; *behind* by the two posterior cerebral arteries.

The student has noticed that two systems of arterial branches supply the brain. (1) The *cortical system* of branches supply the surfaces of the different lobes of the brain and send minute twigs penetrating for some depth into the interior to supply the subjacent brain substance. These vessels anastomose to some extent with each other. (2) The *ganglionic system* of branches penetrate the substance of the brain to supply the basal ganglia. These branches do not anastomose with each other and hence are called terminal arteries.

Veins of the Brain.—These all terminate in the sinuses of the dura mater. The cerebral veins are divi-

sible into two groups external and internal. The *external cerebral veins* are (1) the superior, (2) middle, and (3) inferior. The *superior cerebral veins* are six to twelve in number. They drain the venous blood from the medial surface and from the upper part of the lateral surface of the cerebral hemisphere and open into the superior sagittal sinus (p. 229). The *middle cerebral vein* receives venous blood from the lower part of the lateral surface of the cerebral hemisphere and courses along the lateral fissure from behind forwards to terminate in the cavernous or sphenoparietal sinus. It communicates with one of the superior cerebral veins by means of a venous channel, called the *great anastomotic vein*, and thus indirectly communicates with the sagittal sinus. Behind it also communicates with the transverse sinus by a vein called the *posterior anastomotic vein* which courses over the temporal lobe. The *inferior cerebral veins* are of small size. Those from the orbital surface of the frontal lobe open either into the anterior cerebral vein or into the middle cerebral vein. Those from the back part of the inferior surface open into the basal vein or into the superior petrosal sinus or the transverse sinus. The *anterior cerebral vein* receives venous blood from the medial surface of the cerebral hemisphere. It accompanies the anterior cerebral artery and proceeds to the anterior perforated substance where it opens into the basal vein. The *deep middle cerebral vein* drains venous blood from the insula. It courses along the lateral fissure and opens into the basal vein at the anterior perforated substance.

The *basal vein* is formed by the union of the anterior cerebral vein and deep middle cerebral vein. It is joined by an internal vein, viz., the *inferior striate vein* which emerges from the anterior perforated substance. The basal vein passes backwards round the cerebral peduncle and opens into the internal cerebral vein.

The *great cerebral vein* (vena magna Galeni) is the large vein which drains venous blood from the interior of the cerebrum. Its formation inside the brain will be seen at a later stage of dissection. It issues beneath the posterior end of the corpus callosum and opens into the anterior end of the straight sinus. Its torn end beneath the splenium can now be seen.

The *internal cerebral veins* are two in number; each is formed by the union of the terminal and chorioid veins. These will be examined later on.

The *cerebellar veins* may be grouped into two sets, the superior and inferior. The *superior cerebellar veins* pass forwards and medialwards and open into the straight sinus and into the great cerebral vein. Some pass lateralwards to open into the superior petrosal sinus or transverse sinus. The *inferior cerebellar veins* drain the inferior surface of the cerebellum and open into the occipital, transverse, and superior petrosal sinuses.

The *veins of the pons* pass upwards to end in the basal vein. The *veins of the medulla oblongata* communicate with the veins of the pons above and those of the medulla spinalis below. On the posterior surface of the medulla oblongata they also communicate below with the veins of the spinal medulla and terminate above in the inferior petrosal sinus.

The dissector should now remove the membranes and blood vessels from the surface of the brain. This must be done with caution and special care should be taken at the points where the cerebral nerves are attached to the brain. At the present stage of dissection it is not necessary that the membranes should be removed from the entire brain but the student may remove them from the different parts of the organ as the dissection proceeds.

General Divisions of the Brain.—The mass of nervous mater contained in the cavity of the cranium and known

as the brain may be divided into three parts :—(1) Fore-brain (prosencephalon) which includes the cerebral hemispheres with the cavities inside them called the lateral ventricles and the third ventricle together with the structures bounding it ; (2) the midbrain (mesencephalon which connects the forebrain with the hind brain ; (3) the hind brain (rhombencephalon) which includes the medulla oblongata, the cerebellum and the pons together with the fourth ventricle.

THE CEREBRAL HEMISPHERES.

Each cerebral hemisphere is an ovoid mass and is incompletely separated from its fellow of the opposite side by a median cleft called the *longitudinal fissure.* The surfaces of the hemispheres are mapped out by eminences called *convolutions* or *gyri* separated from each other by furrows called *fissures* or *sulci.* Each hemisphere presents three surfaces and four borders. The *lateral surface* is convex and fits into the concavity of the vault of the cranium. The *medial surface* is flat and is separated from that of the opposite hemisphere by the falx cerebri. The *inferior surface* is irregular and may be subdivided into three portions corresponding to their situation. Thus the anterior portion is formed by the inferior or orbital surface of the frontal lobe. It is concave and lies on the roof of the orbit. The middle portion is formed by the inferior surface of the temporal lobe. It is convex and lies in the middle cranial fossa. The posterior portion is formed by the inferior or tentorial surface of the occipital lobe. It is concave and lies on the tentorium cerebelli. The borders separating these surfaces from each other are ;—(1) the *superomedial border* which separates the lateral from the medial surface. (2) The *inferolate al border* which separates the

lateral from the inferior surface; the front part of this border separating the lateral surface from the orbital portion of the inferior surface is called the *superciliary border*. About two inches in front of the posterior end of the hemisphere there is a notch in the inferolateral border called the *preoccipital notch.* (3) The *medial orbital border* separates the medial surface from the orbital part of the inferior surface. (4) The *medial occipital border* separates the medial surface from the tentorial part of the inferior surface of the occipital lobe. The anterior end of each hemisphere is called the *frontal pole* and the posterior end the *occipital pole.* The anterior end of the temporal lobe is called the *temporal pole.* Structurally the cerebral hemispheres are composed of an outer layer of grey substance or *cortex* and an inner layer of white or *medullary substance.* In addition there are certain collections of grey matter towards the base of each hemisphere called the *basal ganglia.*

The **Longitudinal Fissure** is the antero-posterior cleft in the median plane between the two cerebral hemispheres. In front and behind it completely separates the two hemispheres, but in its middle portion the great transverse commissural band, the corpus callosum, forms its floor and connects the hemispheres together. The falx cerebri projects into it.

The fissures on the cerebral hemispheres are of two kinds, complete and incomplete. The *complete fissures* are produced by infoldings of the whole thickness of the brain wall producing corresponding elevations in the brain cavity. The anterior portions of the calcarine and collateral fissures are complete fissures. The *incomplete fissures* cause indentations on the cortical grey substance and the subjacent white without producing elevations in the brain cavity. The fissures are also

classified into interlobar and intralobar; the former demarcate the different lobes from each other; the latter demarcate the different gyri in a particular lobe.

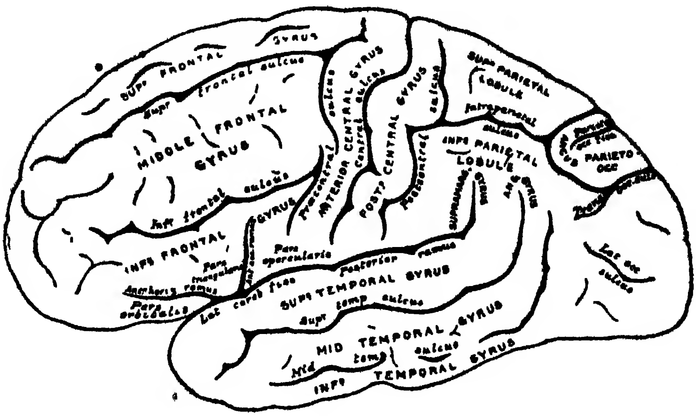


Fig. 86.—Lateral surface of the left cerebral hemisphere, viewed from the side (after Gray).

The interlobar fissures on the lateral surface of each cerebral hemisphere are: (1) the lateral fissure, (2) the central sulcus, (3) the parieto-occipital fissure, and (4) the circular sulcus.

The **Lateral Fissure** (fissure of Sylvius) begins at the inferior surface of the hemisphere and terminates on its lateral surface. It consists of a stem and three rami. The *stem* begins at the anterior perforated substance and passes lateralwards between the orbital surface of the frontal lobe and the anterior end of the temporal lobe. Reaching the lateral surface of the hemisphere it divides into three rami, the anterior horizontal, the anterior ascending, and the posterior. The *anterior horizontal ramus* passes horizontally forwards for about an inch into the lower part of the lateral surface of the

frontal lobe. The *anterior ascending ramus* ascends almost vertically into the lower part of the lateral surface of the same lobe for about an inch. The *posterior ramus* is the continuation backwards and upwards of the stem. It is about three inches in length and lies between the frontal and parietal lobes above and the temporal lobe below. Its terminal portion is bent upwards into the lower part of the parietal lobe.

The **Central Sulcus** (fissure of Rolando) commences at or near the longitudinal fissure a little behind its middle and runs obliquely downwards and forwards along the lateral surface of the cerebral hemisphere to terminate a little above the posterior ramus of the lateral fissure at the junction of its anterior and middle thirds. In its course it presents two bends; the upper bend is called the *superior genu* and has its concavity directed forwards; the lower bend is called the *inferior genu* and has its concavity directed backwards. This fissure separates the frontal lobe from the parietal lobe on the lateral surface.

Parietooccipital Fissure. A small portion of it is seen on the lateral surface of the cerebral hemisphere; the greater portion of it is situated on the medial surface. The *lateral part* passes lateralwards for about half an inch from the longitudinal fissure and is situated about one inch and a half to two inches in front of the occipital lobe. The *medial part* passes downwards and forwards on the mesial surface and meets the calcarine fissure behind the splenium.

The **Circular Sulcus** (limiting sulcus of Reil) surrounds the insula which lies concealed in the lateral fissure. On separating the upper and lower boundaries of the posterior ramus of the lateral fissure the insula will be exposed. The circular sulcus presents three limbs: an *upper limb* separating the insula from the frontal and parietal lobes; a *lower limb* separating it from the temporal

lobe; and an *anterior limb* separating it from the orbital surface of the frontal lobe.

The lobes of each cerebral hemisphere are :—(1) frontal, (2) parietal, (3) temporal, (4) occipital, (5) limbic, and (6) the insula.

The **Frontal Lobe,** on the lateral surface of the hemisphere, is bounded behind by the central sulcus, below by the posterior ramus of the lateral fissure. Its inferior or orbital surface is bounded behind by the stem of the lateral fissure. Its medial surface is not demarcated from that of the parietal lobe by any fissure but a line drawn from the upper end of the central sulcus vertically downwards along the medial surface serves as the boundary line between the medial surfaces of the two lobes.

The lateral surface of the frontal lobe presents three main sulci which map out four gyri. The sulci are :—(1) The *precentral sulcus* which lies in front of the central sulcus and parallel to it. It consists of two parts, an upper and a lower, which are usually not connected with each other. (2) The *superior frontal sulcus* passes almost horizontally forwards from the upper part of the precentral sulcus. (3) The *inferior frontal sulcus* passes forwards and slightly downwards from the lower part of the precentral sulcus. The gyri are :—(1) The *anterior central gyrus* (ascending frontal convolution) which lies between the central and precentral sulci. It is the *motor area* of the cortex. (2) The *superior frontal gyrus* lies above the superior frontal sulcus and encroaches on the medial surface. It is frequently subdivided into an upper and a lower part by an antero-posterior furrow called the *paramedial frontal sulcus.* (3) The *middle frontal gyrus* lies between the superior and inferior frontal sulci and is limited behind by the precentral sulcus. (4) The *inferior frontal gyrus* lies in front of the precentral sulcus and below the inferior frontal sulcus. It is limited

below by the superciliary border which separates it from the orbital surface. This gyrus is subdivided into three parts by the anterior horizontal and anterior ascending rami of the lateral fissure. The portion lying below the anterior horizontal ramus is called the *pars orbitalis.* The portion lying between the anterior horizontal and anterior ascending rami is called the *pars triangularis.* The portion lying behind the anterior ascending ramus is called the *pars basilaris.* The left inferior frontal gyrus is called Broca's convolution as Broca localised it as the centre for articulate speech.

The inferior or orbital surface of the frontal lobe presents two sulci ; the olfactory sulcus and the H-shaped orbital sulcus. The *olfactory sulcus* lies close to the medial orbital border and lodges the olfactory tract and bulb. The H-shaped *orbital sulcus* lies lateral to the olfactory sulcus and presents two antero posterior limbs, one medial and the other lateral, connected in the middle by a transverse limb like the letter H. The orbital surface of the frontal lobe is mapped out into five gyri. (1) The *gyrus rectus* lies between the medial border and the olfactory sulcus. (2) The *medial orbital gyrus* lies between the olfactory

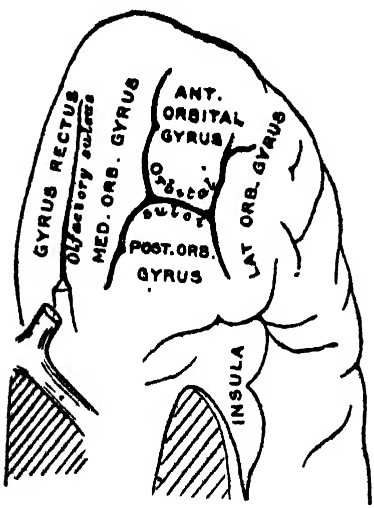


Fig. 87.—Orbital surface of the left frontal lobe (after Gray).

sulcus and the medial limb of the H-shaped orbital sulcus. The gyrus rectus and the medial orbital gyrus are continuous with the superior frontal gyrus on the lateral surface of the hemisphere. (3) The *anterior orbital gyrus* lies in front of the transverse limb of the orbital sulcus. It is continuous with the middle frontal gyrus. (4) The *lateral orbital gyrus* lies lateral to the lateral limb of the orbital sulcus and is continuous with the inferior frontal gyrus. (5) The *posterior orbital gyrus* lies behind the transverse limb of the orbital sulcus.

The medial surface of the frontal lobe will be studied later on.

Parietal Lobe.—The lateral surface of the parietal lobe is bounded in front by the central sulcus, behind by the lateral part of the parietooccipital fissure and by a line drawn from the lower extremity of this fissure to the preoccipital notch, below by the posterior ramus of the lateral fissure and an imaginary line drawn backwards in continuation of the same ramus to meet the posterior boundary. It presents the following sulci :— (1) The postcentral sulcus which lies behind and parallel to the central sulcus. It is sometimes interrupted in the middle presenting an upper limb and a lower limb. (2) The *intraparietal sulcus* passes almost horizontally backwards from the middle of the post-central sulcus. It is prolonged behind into the occipital lobe as the occipital ramus of the intraparietal sulcus and terminates by joining the transverse occipital sulcus behind the lateral parietooccipital fissure. Sometimes there is an interruption between the occipital ramus and the intraparietal sulcus. The gyri on the lateral surface of the parietal lobe are :—(1) The *posterior central gyrus* (ascending parietal convolution) which lies between the central sulcus in front and the postcentral sulcus behind. It is continuous in front with the precentral

gyrus round the upper and lower ends of the central sulcus. (2) The *superior parietal lobule* is bounded in front by the upper part of the postcentral sulcus and is continuous in front with the postcentral gyrus above the upper end of the postcentral sulcus. Behind it is the lateral parietooccipital fissure and below the lower end of this fissure it is connected with the occipital lobe by a connecting gyrus called the *arcus parietooccipitalis*; below it is bounded by the intraparietal sulcus. (3) The *inferior parietal lobule* is bounded in front by the lower part of the postcentral sulcus, above by the intraparietal sulcus, below by the lower boundary of the parietal lobe and behind by the imaginary line which bounds the parietal lobe posteriorly. This lobule is further subdivided into two gyri, viz., (*a*) the *supramarginal gyrus* which lies around the upturned end of the posterior ramus of the lateral fissure and is continuous in front with the postcentral gyrus and behind with the superior temporal gyrus; (*b*) The *angular gyrus* which lies around the upturned end of the superior temporal sulcus.

The medial surface of the parietal lobe will be studied later on.

The **Occipital Lobe** forms the posterior part of the hemisphere. Its lateral surface is bounded in front by the lateral part of the parietooccipital fissure and by a line drawn from its lower end to the preoccipital notch. The sulci on its lateral surface are :—(1) The *transverse occipital sulcus* which lies behind the lateral part of the parietooccipital fissure and which is joined in front by the occipital ramus of the intraparietal sulcus. (2) The *lateral occipital sulcus* which passes from behind forwards on the lateral surface of the occipital lobe. The gyri on its lateral surface are :—(1) The *superior occipital gyrus* which lies above the lateral occipital sulcus. (2) The *inferior occipital gyrus* which lies below the same

sulcus. (8) The *arcus parietooccipitalis* lies in front of the transverse occipital sulcus and has been already described.

The inferior or tentorial surface of the occipital lobe is continuous in front with the inferior surface of the temporal lobe and is demarcated from it by an imaginary line passing transversely from the preoccipital notch. This surface presents the posterior end of the collateral fissure which runs from behind forwards into the temporal lobe and separates the posterior ends of the lingual and fusiform gyri. The *fusiform gyrus* lies laterally while the *lingual gyrus* lies medially and encroaches on the medial surface of the occipital lobe.

The medial surface of the occipital lobe will be studied later on.

The **Temporal Lobe** is situated below the posterior ramus of the lateral fissure and in front of the occipital lobe. Its lateral surface is mapped out into three gyri by two sulci. The sulci are :—The *superior temporal sulcus* (parallel sulcus) which lies below the posterior ramus of the lateral fissure and runs parallel to it. It extends from the temporal pole to a little behind the upturned end of the posterior ramus of the lateral fissure. (2) The *middle temporal sulcus* which lies below the preceding and runs parallel to it. It is often interrupted in the middle. The gyri are :—(1) The *superior temporal gyrus* which lies between the posterior ramus of the lateral fissure and the superior temporal sulcus. It is continuous behind with the supramarginal gyrus. (2) The *middle temporal gyrus* which lies between the superior and middle temporal sulci. It is continuous behind with the angular gyrus. (3) The *inferior temporal gyrus* which lies below the middle temporal gyrus and is continuous behind with the inferior occipital gyrus.

The inferior surface of the temporal lobe presents

the following sulci :—(1) The *inferior temporal sulcus* which lies most laterally and runs anteroposteriorly. It separates the inferior temporal gyrus laterally from the fusiform gyrus lying medially. (2) The *collateral fissure* which lies medial to the fusiform gyrus and separates it from the lingual gyrus behind and the hippocampal gyrus in front. Behind it is continued along the inferior surface of the occipital lobe and in front it terminates a little behind the temporal pole. (3) *Chorioidal fissure.*—A portion of this fissure is seen extending from below the splenium towards the anterior end of the temporal lobe. It forms the upper and medial boundary of the inferior surface of the temporal lobe and through it a vascular fold of pia mater, the chorioid plexus, enters the inferior cornu of the lateral ventricle. The gyri on the inferior surface of the temporal lobe are :—(1) The *inferior temporal gyrus* which lies lateral to the inferior temporal sulcus and is continuous with the same gyrus seen on the lateral surface. (2) The *fusiform gyrus* which lies between the inferior temporal sulcus and the collateral fissure. Behind it is continued to the inferior surface of the occipital lobe. (3) The *hippocampal gyrus* lies between the collateral and chorioidal fissures. Its anterior extremity is bent upwards on itself like a hook and is called the *uncus.* The uncus is separated from the temporal pole by a slight cleft called the *incisura temporalis.* Behind and below the hippocampal gyrus is continuous with the lingual gyrus; behind and above with the cingulate gyrus lying above the corpus callosum.

The superior surface of the temporal lobe presents some gyri concealed in the posterior ramus of the lateral fissure. These gyri pass from behind forwards and lateralwards and are called the *transverse temporal gyri.*

Limbic Lobe.—This name is given to certain gyri included in the four lobes described above, and lying in con-

tinuity on the medial surface of each hemisphere. These gyri will be studied when the medial surface of the cerebral hemisphere is examined.

The Insula (Island of Reil) lies concealed at the bottom of the lateral fissure. To see the insula it is necessary to separate widely the lips of that fissure. It then appears as a somewhat triangular eminence with its apex at the commencement of the stem of the lateral fissure. The gyri which bound the lateral fissure overlap the insula and are called the *opercula of the insula.* These opercula, four in number, are separated from each other by the three limbs of the lateral fissure and are named the orbital, frontal, frontoparietal, and temporal opercula. The *orbital operculum* lies below the anterior horizontal ramus of the lateral fissure. The *frontal operculum* lies between the anterior ascending and anterior horizontal rami. The *fronto-parietal operculum* lies between the anterior ascending ramus and the terminal part of the posterior ramus of the same fissure. The *temporal* operculum is formed by the upper margin of the superior temporal gyrus. The circular sulcus surrounds the insula (p. 455).

Gyri of the insula.—The surface of the insula is subdivided by a sulcus called the *sulcus centralis insulæ.* It runs from the apex of the insula upwards and backwards. The gyri lying in front of the sulcus are three or four in number and are called *short gyri* while the gyrus lying behind the sulcus is long and is called the *long gyrus.*

The olfactory lobe should be studied now.

Olfactory Lobe.—This name is given to the following parts lying in continuity :—(1) The olfactory bulb, (2) the olfactory tract, (3) the olfactory trigone, (4) the parolfactory area of Broca, and (5) the anterior perforated substance.

The *olfactory bulb* is the enlarged anterior end of the olfactory tract. It lies in the groove on the upper surface of the lamina cribrosa of the ethmoid bone. To its lower surface are attached the olfactory nerve filaments.

The *olfactory tract* is the narrow part behind the olfactory bulb. It lies in the olfactory sulcus on the orbital surface of the frontal lobe. It is triangular on section, the apex of the triangle being received into the olfactory sulcus.

The *olfactory trigone* is the triangular elevation at the back part of the olfactory tract with its apex in front. From the lateral angle of the olfactory trigone the *lateral olfactory stria* passes along the lateral part of the trigone and the anterior perforated substance to the uncus of the hippocampal gyrus. From the medial angle of the olfactory trigone the *medial olfactory stria* passes along the medial aspect of the trigone medialwards to the subcallosal gyrus situated beneath the anterior part of the corpus callosum.

The *parolfactory area of Broca* is a small triangular area situated in front of the subcallosal gyrus on the medial surface of the hemisphere.

The *anterior perforated substance* is so called on account of its being perforated by blood vessels, viz., the antero-lateral ganglionic arteries. It is bounded in front by the olfactory trigone, behind by the optic tract, laterally by the lateral olfactory stria and medially by the medial olfactory stria.

The medial surface of the cerebral hemisphere is now to be studied. For this the left hemisphere is to be sliced off with a long knife about half an inch above the level of the corpus callosum. The cut surface presents an oval mass of white matter surrounded on all sides by a convoluted layer of grey matter. This oval area is called the *centrum ovale minus* and its surface is spotted

with red dots (puncta vasculosa) which are the cut ends of minute blood vessels.

Medial Surface of the Cerebral Hemisphere.—The fissures and sulci on the medial surface are:—(1) the *callosal fissure* which is a slit-like interval lying between

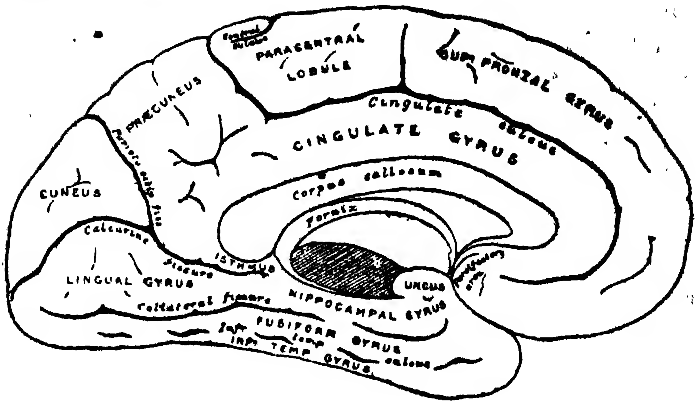


Fig. 88.—Medial surface of the left cerebral hemisphere (after Gray).

the convex surface of the corpus callosum and the overlying gyrus. (2) The *cingulate sulcus* begins below the anterior end of the corpus callosum and, curving round its genu, passes backwards parallel to the callosal sulcus. Its posterior end turns upwards and cuts the superomedial border behind the upper end of the central sulcus. Opposite the upper end of the precentral sulcus it sends an offset towards the superomedial border. (3) The *medial part of the parietooccipital fissure* has been described with the parietooccipital fissure. (4) The *calcarine fissure* is a complete fissure. It begins close to the occipital pole and, running forwards and slightly upwards, joins the parietooccipital fissure behind the

splenium. It continues its course further forwards and ends below the splenium. (5) The *subparietal sulcus* lies between the posterior end of the cingulate sulcus and the medial part of the parietooccipital fissure. It is in the same line with the back part of the cingulate sulcus excluding its upturned end.

The gyri on the medial surface of the cerebral hemisphere are :—(1) The *superior frontal gyrus*, which has been seen on the lateral surface of the hemisphere. On the medial surface it lies between the cingulate sulcus below and the superomedial border above. Behind it is limited by the offset from the cingulate sulcus which passes upwards towards the upper end of the precentral sulcus. (2) The *paracentral lobule* is bounded in front by the offset of the cingulate sulcus and behind by the upturned end of the same sulcus. It is continuous with the anterior and posterior central gyri. (3) The *precuneus* or *quadrate lobe* corresponds to the medial surface of the superior parietal lobule. It is bounded in front by the upturned end of the cingulate sulcus, behind by the medial part of the parietooccipital fissure, above by the superomedial border and below by the subparietal sulcus. (4) The *cuneus* is a wedge-shaped or triangular gyrus lying between the medial part of the parietooccipital fissure and the calcarine fissure. (5) The *lingual gyrus* lies between the calcarine and collateral fissures. It occupies both the medial and inferior surfaces of the hemisphere. It is continuous in front with the hippocampal gyrus. (6) The *cingulate gyrus* is a curved convolution lying between the callosal fissure below and the cingulate and subparietal sulci above. It surrounds the corpus callosum and is connected behind the splenium with the hippocampal gyrus by a narrow gyrus, called the *isthmus*, which lies between the splenium and the anterior end of the calcarine fissure.

Limbic Lobe.—The cingulate gyrus together with the hippocampal gyrus and the isthmus form a continuous gyrus which was described by Broca as the limbic lobe.

Part of the cingulate gyrus of the left cerebral hemisphere still covers the corpus callosum. Divide the whole depth of the cingulate gyrus to the level of the convex surface of the corpus callosum by a transverse cut. Lift the cut ends forwards and backwards from the surface of the corpus callosum. On the deep surface of the raised cingulate gyrus a bundle of longitudinal white fibres will be seen. Detach this bundle from the deep surface of the cingulate gyrus and note its connections anteriorly and posteriorly by pulling it. This bundle is called the cingulum.

The *cingulum* is a longitudinal bundle of association fibres lying on the deep surface of the cingulate gyrus and on the superior surface of the corpus callosum. Traced in front it terminates at the anterior perforated substance. Traced behind it ends in the hippocampal gyrus.

THE BASE OF THE BRAIN.

The base of the brain should be studied as a whole. Omitting for the present the superficial attachments of the cerebral nerves the following parts are to be examined :—(1) The anterior end of the longitudinal fissure ; (2) the inferior surface of the frontal lobe on either side of the longitudinal fissure together with the olfactory tract and bulb ; (3) the rostrum or anterior terminal part of the corpus callosum ; (4) the lamina terminalis ; (5) the optic chiasma and the optic tracts ; (6) the anterior perforated substance ; (7) the tuber cinereum ; (8) the infundibulum and the hypophysis ; (9) the corpora mamillaria ; (10) the

posterior perforated substance; (11) the inferior surfaces of the temporal lobes; (12) the peduncles of the cerebrum;

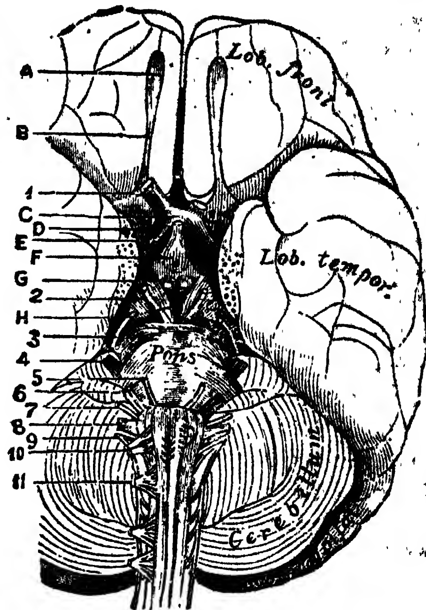


Fig. 89.—Base of the brain (Gegenbaur).

A. Olfactory bulb.
B. Olfactory tract.
C. Optic chiasma.
D. Anterior perforated substance.
E. Optic tract.
F. Infundibulum.
G. Corpora mamillaria.
H. Posterior perforated substance.
1. Optic nerve.
2. Oculomotor nerve.
3. Trochlear nerve.
4. Trigeminal nerve.
5. Abducent nerve.
6. Facial and acoustic nerves.
7. Glossopharyngeal nerve.
8. Vagus nerve.
9. Accessory nerve.
10. Hypoglossal nerve.
11. First cervical nerve.

(13) the anterior surfaces of the pons and the medulla oblongata; (14) the inferior surface of the cerebellum.

Of these the longitudinal fissure and the inferior surface of the frontal lobe have been already examined. The rostrum will be described with the corpus callosum.

The **Lamina Terminalis** (Lamina cinerea) is a thin layer of grey matter which passes downwards and backwards from the rostrum of the corpus callosum to the upper surface of the optic chiasma. At a later stage of the dissection it will be seen to form the anterior boundary of the third ventricle.

The **Optic Chiasma** (Optic commissure) is a short

commissural band which connects the two optic tracts. In it the decussation of the medial fibres of the optic nerves takes place. From its postero-lateral angles the *optic tracts* pass backwards and lateralwards winding round the cerebral peduncles. The optic chiasma receives the optic nerves at its antero-lateral angles.

The anterior perforated substance has been examined.

The **Interpeduncular Fossa** is a lozenge-shaped space bounded anteriorly by the optic chiasma, antero-laterally by the optic tracts, posteriorly by the pons, and postero-laterally by the cerebral peduncles. This space corresponds to the floor of the third ventricle and contains the following structures from before backwards:—the tuber cinereum, infundibulum and hypophysis, corpora mamillaria, the posterior perforated substance, and the oculomotor nerves.

The **Tuber Cinereum** is a slight eminence of grey matter placed immediately behind the optic chiasma and between the optic tracts.

The **Infundibulum** is a hollow conical process which projects downwards from the tuber cinereum and becomes attached to the posterior lobe of the hypophysis.

The **Hypophysis** (Pituitary body) is an oval reddish grey mass which is lodged in the fossa hypophyseos of the sphenoid where it is retained by the diaphragma sellæ. Its long axis is transverse and it is somewhat flattened from above downwards. It consists of a larger anterior and a smaller posterior lobe. The anterior lobe is developed as a pouch from the buccal cavity of the embryo and presents a concavity behind where the posterior lobe is received. The posterior lobe is developed from the brain and is connected with the tuber cinereum by the infundibulum. Divide the hypophysis antero-posteriorly and note the junction of the anterior and posterior lobes.

The **Corpora Mamillaria** (Corpora albicantia) are two small rounded white bodies, each of the size of a small pea. They are placed side by side behind the tuber cinereum. They consist of white matter externally and grey matter internally. Their connections with the columns of the fornix and the thalamus will be traced later on.

The **Posterior Perforated Substance** (Posterior perforated space) is composed of grey matter and is so called on account of its being perforated by numerous small apertures for the passage of vessels, viz., the postero-medial ganglionic arteries. It is situated between the corpora mamillaria in front and the diverging cerebral peduncles behind.

The inferior surfaces of the temporal lobes have been described. The cerebral peduncles, the anterior surfaces of the pons and medulla oblongata, and the inferior surface of the cerebellum will be studied later on.

It has already been noted that there are twelve pairs of cerebral nerves. Each of them is attached to the surface of the brain at a particular area which is called the superficial origin of the nerve. In the case of motor nerves they really issue out of the brain at the areas of superficial origins whereas in the case of sensory nerves they really enter the brain at those areas to gain the interior of the brain. Strictly speaking therefore, the superficial origin should be called the *superficial attachment* of a cerebral nerve. If these nerves are traced from their superficial attachments inside the brain they will be found to be connected with nuclei of grey matter in the substance of the brain. (These nuclei are called the *nuclei of origin* in the case of motor nerves and the *nuclei of termination* in the case of the sensory nerves.)

Superficial Attachments of the Cerebral Nerves.—The attachment of the *olfactory nerves* to the olfactory

bulb has been examined. The *optic nerve* is continuous with the antero-lateral aspect of the optic chiasma. The *oculomotor nerve* is attached to a groove, called the oculomotor sulcus, on the medial aspect of the cerebral peduncles. The *trochlear nerve* is attached to the dorsal aspect of the midbrain behind the corpora quadrigemina. It winds round the lateral side of the cerebral peduncle to reach the base of the brain. The *trigeminal nerve* consists of a large sensory root and a small motor root. Both are attached to the side of the pons near its upper border. The motor root lies in front of and medial to the sensory root at the sites of their attachments. The *abducent nerve* is attached to the groove at the lower border of the pons close to the middle line. The *facial* and *acoustic nerves* are attached to the groove below the lateral part of the lower border of the pons, the former nerve lying medial to the latter. The *glossopharyngeal, vagus* and *accessory nerves* are attached in a continuous line by filaments to the postero-lateral sulcus of the medulla oblongata. The spinal attachment of the accessory nerve will be seen during the dissection of the medulla spinalis. The *hypoglossal nerve* is attached by many filaments to the antero-lateral sulcus of the medulla oblongata.

The gyri from the right cerebral hemisphere are to be removed above the level of the corpus callosum. These gyri should be broken and not sliced off. While the gyri are being broken the direction of the fibres of the corpus callosum are to be noted. Both the hemispheres are now to be sliced off to the level of the upper surface of the corpus callosum. A large mass of white substance surrounded by convoluted grey matter is exposed. This is called the *centrum ovale majus*. The upper surface of the corpus callosum is well revealed now.

The Corpus Callosum is the great transverse com-

missure which connects the two cerebral hemispheres. It consists of a thick stratum of white substance composed mainly of transverse fibres. It is situated at the bottom of the longitudinal fissure and measures about four inches antero-posteriorly. It is nearer to the frontal than to the occipital pole, and is thicker at the ends than at the middle. Its superior surface is convex from before backwards and is covered by a very thin layer of grey matter, called the supracallosal gyrus. Along the middle line there is a faint antero-posterior groove. On either side of this groove is a thin linear elevation in the supracallosal gyrus formed by longitudinal fibres, called the *stria longitudinalis medialis*. Lateral to this on either side is another longitudinal linear elevation, called the *stria longitudinalis lateralis*. The superior surface is covered laterally by the cingulate gyrus. The anterior end of the corpus callosum is bent and then reflected downwards and backwards; the bend is called the *genu* and the reflected portion, the *rostrum*. The rostrum gradually becomes thinner and is connected below with the lamina terminalis. The posterior end of the corpus callosum is the thickest part and is rounded and free. It is called the *splenium*.

The *supracallosal gyrus* is the thin layer of grey matter with the striæ longitudinales in it covering the upper surface of the corpus callosum. Traced in front it is seen to be prolonged round the genu and the rostrum to be continuous with the subcallosal gyrus. Traced behind it is continued below the splenium as a thin ridge called the *fasciola cinerea* into the hippocampal gyrus.

The *fibres of the corpus callosum* run for the most part transversely. But the fibres from the genu on entering the hemisphere radiate forwards to the frontal pole forming what is called the *forceps anterior* (minor). The fibres from the splenium on entering the hemisphere pass

backwards towards the occipital pole forming the *forceps posterior* (major). The intermediate fibres sweep across the roof and lateral wall of the lateral ventricle into the temporal lobe forming what is called the *tapetum*.

To open the lateral ventricles a longitudinal incision should be made through the superior surface of the corpus callosum on either side of the median longitudinal groove. Introduce the handle of the scalpel through this incision and raise the lateral portion of the corpus callosum with it. Remove this lateral portion of the corpus callosum by dividing it at its attachment laterally. The central portion and the anterior cornu of the lateral ventricle is now exposed. Carry the knife backwards into the occipital pole dividing the roof of the posterior cornu. Remove a portion of its roof to expose it more fully. From the junction of the central portion and the posterior cornu of the lateral ventricle another cavity, called the inferior cornu, will be seen passing downwards and forwards through the temporal lobe up to its anterior end. Open up the inferior cornu by cutting through its lateral wall along the superior temporal sulcus; the sulcus will serve well as the guide. When the inferior cornu has been opened up from the beginning to the end, part of its lateral wall should be removed to fully expose its roof and floor.

The **Lateral Ventricles** are two irregular cavities one in each hemisphere of the brain and separated from each other by a median partition extending from the floor to the roof called the *septum pellucidum*. They are lined by a thin membrane called the *ependyma* and contain a serous fluid called the cerebrospinal fluid. They communicate with the third ventricle by an aperture, called the *interventricular foramen*, which is placed in front of the anterior end of the thalamus. Each lateral

ventricle consists of a central part, an anterior cornu, a posterior cornu, and an inferior cornu.

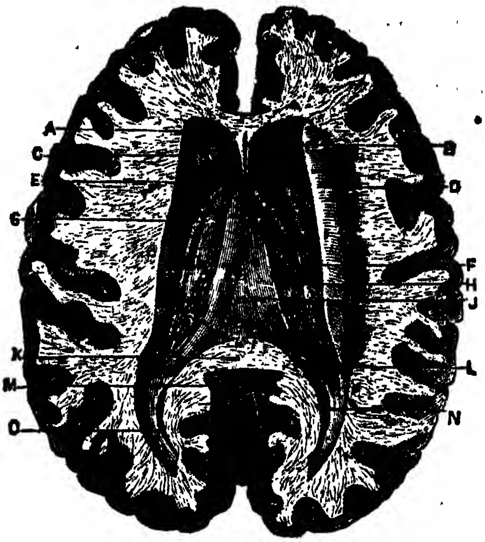


Fig. 90.—Lateral ventricles of the brain (from Hirschfeld and Leveille).

A. Septum pellucidum.
B. Cavum septum pellucidi.
C. Corpus striatum.
D. Corpus callosum, reflected.
E. Interventricular foramen.
F. Stria terminalis.
G. Thalamus.
H. Chorioid plexus.
J. Fornix.
K. Posterior extremity of corpus callosum.
L. Commencement of inferior cornu.
M. Great cerebral vein.
N. Calcar avis.
O. Posterior cornu of lateral ventricle.

The **Central Part** (body) extends from the splenium of the corpus callosum behind to the interventricular foramen in front. Its *roof* is formed by the undersurface of the corpus callosum and its *medial wall* by the back part of the septum pellucidum. *Laterally* the roof meets with the floor. Its *floor* is formed from before back-

wards by (1) the caudate nucleus, (2) the terminal vein, (3) the stria terminalis, (4) the thalamus, (5) the chorioid plexus, and (6) the fornix. The *caudate nucleus* is a mass of grey matter enlarged at its anterior end but gradually tapering posteriorly forming its tail which is prolonged into the inferior cornu. The *terminal vein* (vein of the corpus striatum) opens into the internal cerebral vein at the interventricular foramen. The *stria terminalis* (tænia semicircularis) lies in the groove between the caudate nucleus and the thalamus. It is a linear band of white matter which passes in front towards the inter ventricular foramen. Behind it passes along the roof of the inferior cornu. A very narrow portion of the lateral part of the upper surface of the *thalamus* is seen between the chorioid plexus and the stria terminalis. The *chorioid plexus* is a vascular fringe of pia mater which appears in the lateral ventricle between the lateral edge of the fornix and the thalamus. In front it is continuous with the chorioid plexus of the lateral ventricle of the opposite side through the interventricular foramen. Posteriorly it passes into the inferior cornu. Its surface is lined by the ependymal covering of the lateral ventricle. The lateral edge of the *fornix* is seen in the central part of the lateral ventricle. The fornix will be studied in detail later on.

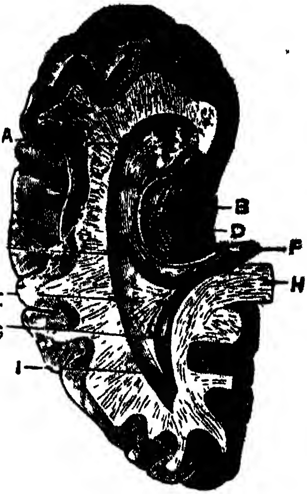
The **Anterior Cornu** (anterior horn) lies in front of the interventricular foramen. It passes forwards, lateralwards and slightly downwards. Its *roof* is formed by the front part of the corpus callosum; its *floor* by the rostrum of the corpus callosum; its *medial wall* by the front part of the septum pellucidum; and its *lateral wall* by the head of the caudate nucleus.

The **Posterior Cornu** extends backwards from the splenium to the occipital lobe. It is curved; the convexity of the curve is directed lateralwards. Its *roof*

and *lateral wall* are formed by the tapetum of the corpus callosum. Its *medial wall* presents two elongated eleva-

Fig. 91.—Inferior and posterior cornua of the lateral ventricle of brain (from Hirschfeld and Leveille).

A. Pes hippocampi.
B. Fimbria hippocampi.
C. Hippocampus.
D. Fascia dentata.
E. Eminentia collateralis.
F. Crus of fornix (cut)
G. Calcar avis (the forceps posterior is seen on the medial side of this in continuity with the splenium).
H. Splenium of corpus callosum (cut).
I. Posterior cornu.



tions. The upper of the two is called the *bulb of the posterior cornu* and is formed by the fibres of the forceps posterior. The lower elevation is called the *calcar avis* (hippocampus minor) and is caused by the infolding of the ventricular wall at the anterior end of the calcarine fissure. The handle of the scalpel may be pushed through the fissure to verify it. The posterior extremity of the posterior cornu is tapering.

The **Inferior Cornu** (descending horn) of the lateral ventricle runs into the temporal lobe and passes at first backwards and lateralwards and then turns downwards and forwards and finally bends medialwards ending about an inch behind the temporal pole. Its *roof* is formed chiefly by the tapetum but the tail of the caudate nucleus also passes forwards in the roof to terminate in a small nucleus of grey matter called the *amygdaloid*

nucleus. This nucleus produces an elevation in the anterior end of the roof and if it is divided the grey colour of the nucleus will be seen. The stria terminalis also lies in the roof and terminates in the amygdaloid nucleus. The *floor* of the inferior cornu presents the following parts: (1) the hippocampus, (2) the fimbria hippocampi, (3) the collateral eminence, (4) the chorioid plexus, and (5) the trigonum collaterale. These parts should now be examined in detail.

The **Hippocampus** (hippocampus major) is an elongated conspicuous eminence, occupying the whole length of the floor of the inferior cornu. It rigidly follows the curve of the cornu and at its lower end becomes expanded and indented on the surface so as to resemble the paw of an animal. Hence this terminal portion is called the *pes hippocampi*. The amygdaloid nucleus lies on the roof opposite the pes hippocampi. The hippocampus is covered by the chorioid plexus. In structure it consists principally of grey matter but has a thin layer of white matter on the ventricular surface termed the *alveus*.

The *fimbria hippocampi* (corpus fimbriatum, tænia hippocampi) is a narrow band of white matter which is attached to the medial concave border of the hippocampus. It is continuous above with the crus of the fornix and terminates below at the uncus. Its medial margin is free. Laterally it spreads over the hippocampus as a thin layer of white matter, called the alveus, already referred to.

The **Collateral Eminence** is an elongated projection on the floor of the inferior cornu situated on the lateral side of the hippocampus. It is produced by an infolding of the ventricular wall corresponding to the middle part of the collateral fissure. The handle of the scalpel may be introduced into the collateral fissure to verify this.

The Chorioid Plexus is the vascular fringe of pia mater

which has been pushed into the inferior cornu of the lateral ventricle through the chorioid fissure. It is continuous behind the thalamus with the chorioid plexus of the central part of the lateral ventricle. It is covered by the ependyma of the ventricle.

The *trigonum collaterale* is the smooth triangular space seen in the floor of the inferior cornu at the angle of divergence of the posterior and inferior cornua.

Detach the remaining portion of the right occipital and temporal lobes forming the floors of the posterior and inferior cornua by dividing the forceps posterior and the frimbria hippocampi at its junction with the crus of the fornix. In the detached piece the floor of the inferior cornu can be more thoroughly examined. On raising the free margin of the frimbria hippocampi a narrow layer of grey matter is exposed, the surface of which is marked by many transverse ridges and furrows. This structure is called the fascia dentata hippocampi.

The *fascia dentata hippocampi* (dentate gyrus) lies on the upper surface of the hippocampal gyrus. Its free surface is marked by transverse ridges and furrows and is covered by the fimbria hippocampi. The cleft between it and the fimbria hippocampi is called the *fimbrio-dentate sulcus*. Behind it is continuous with the fasciola cinerea beneath the splenium. In front it is continued into the uncus as a curved band called the *band of Giacomini*.

Remove the medial strip of corpus callosum which is adherent behind to the fornix and in front to the septum pellucidum.

The **Septum Pellucidum** (septum lucidum) is the partition between the anterior cornua and the anterior ends of the central parts of the lateral ventricles. It consists of two thin laminæ, separated from each other by a narrow chink called the *cavum septi pellucidi* (fifth

ventricle). Above it is attached to the undersurface of the corpus callosum and below to the rostrum in front and to the fornix behind.

The Fornix (Fig. 90) is a band of white matter situated below the corpus callosum. It extends from before backwards in the form of an arch, the convexity of which is directed upwards. It consists of two lateral halves; the central parts of which are joined together in the middle line while their anterior and posterior parts diverge from each other. The central joined parts constitute the body; the anterior parts are called the columns of the fornix; and the posterior parts, the crura.

The *body* of the fornix is triangular, being narrow in front and broad behind. Its upper surface, in the median line, is attached behind to the undersurface of the corpus callosum and in front to the septum pellucidum. The lateral portions of the upper surface form the floor of the lateral ventricles. Its lower surface rests on the fold of pia mater which forms the roof of the third ventricle. Its lateral border is separated from the thalamus by the chorioid plexus.

The *columns* of the fornix (anterior pillars) pass downwards in front of the interventricular foramen. Each column passes under cover of the ependyma of the lateral wall of the third ventricle to the base of the brain to terminate in the corpus mamillare. From here a fresh bundle of fibres, called the *thalamomamillary fasciculus* (bundle of Vicq d' Azyr), arises and passes to the anterior tubercle of the thalamus. The course of the column along the lateral wall of the ventricle to the corpus mamillare and that of the thalamomamillary fasciculus, will be traced after the examination of the third ventricle.

The *crura* of the fornix (posterior pillars) are the posterior prolongations from the body of the fornix and

are at first attached to the undersurface of the corpus callosum. Each crus diverges from its fellow of the opposite side and curves lateralwards and downwards round the posterior end of the thalamus to be continuous with the fimbria hippocampi in the inferior cornu of the lateral ventricle. If the body of the fornix is cut through transversely at its middle and the posterior end held backwards a triangular lamina will be seen between the diverging crura encroaching on the back part of the undersurface of the body of the fornix. This lamina is called the *lyra* and it is traversed by transverse fibres connecting the two crura and through them the hippocampi of the two sides. These transverse fibres form the *hippocampal commissure.*

The **Chorioidal Fissure** should now be studied in its entirety. Its lower part through which the chorioid plexus of the inferior cornu of the lateral ventricle enters has been studied. Its upper part begins at the interventricular foramen and passes backwards between the lateral margin of the body of the fornix and the upper surface of the thalamus. At the commencement of the inferior cornu the fissure lies between the crus of the fornix and the posterior end of the thalamus. In the inferior cornu it lies between the stria terminalis on the roof and the fimbria hippocampi on the floor. Through the fissure the chorioid plexus protrudes into the central part and inferior cornu of the lateral ventricle pushing the ependyma before it.

The **Tela Chorioidea of the Third Ventricle** (velum interpositum) is a double layer of pia mater which penetrates into the ventricles through the central portion of the transverse fissure beneath the splenium. It is placed beneath the body of the fornix forming the roof of the third ventricle. It is triangular in shape; its apex reaches as far forwards as the interventricular foramen;

and its base lies under the splenium at the transverse fissure. Along its lateral margin is the chorioid plexus which protrudes into the central portion of the lateral ventricle through the upper part of the chorioidal fissure. From its undersurface, on either side of the middle line, projects a linear vascular fringe called the *chorioid plexus of the third ventricle.* Between the two layers of the tela chorioidea are contained the internal cerebral veins (veins of Galen) one on either side. Each of these veins is formed in front at the interventricular foramen by the union of the terminal vein with the chorioidal vein. It proceeds backwards close to the median line and unites with its fellow of the opposite side forming the *great cerebral vein* (vena magna Galeni) which opens into the straight sinus.

The **Transverse Fissure of the Brain** is the cleft through which the invagination of the pia mater forming the tela chorioidea of the third ventricle, and that of the chorioid plexus of the inferior cornu of the lateral ventricle take place. It consists of a central portion lying between the splenium above and the midbrain below and two lateral portions which coincide with the lateral parts of the chorioidal fissure. The transverse fissure must be differentiated from the chorioidal fissure. The lateral portions of the former are the same as the lateral portions of the latter, but the central portion of the transverse fissure does not coincide with the upper part of the chorioidal fissure. The latter fissure lies between the lateral margin of the fornix and the thalamus.

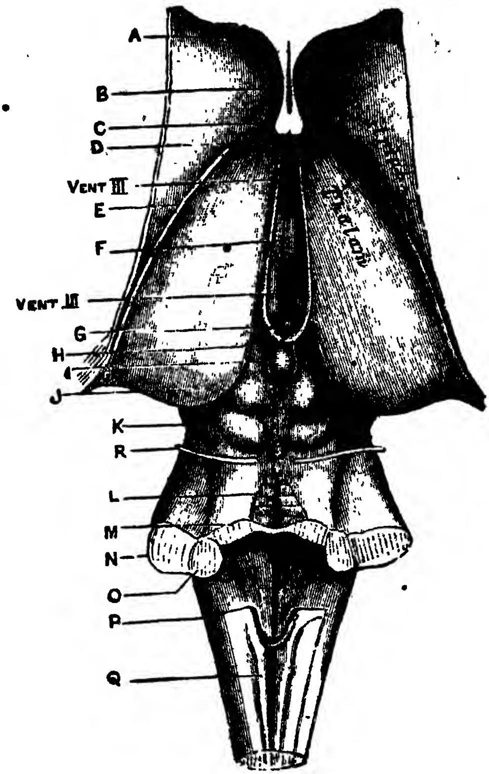
THALAMENCEPHALON.

The student should now examine the thalamus and certain parts lying in its neighbourhood, which together constitute the thalamencephalon.

The **Thalamus** (optic thalamus) (Fig. 92) is a large oval-shaped mass of grey matter coated on its superior surface by a thin layer of white matter called the *stratum zonale.* The thalami are two in number situated one on either side of the third ventricle. Each presents four surfaces and two ends. The *superior surface* is convex and is bounded laterally by the oblique groove which separates it from the caudate nucleus and contains the stria terminalis and the terminal vein. Medially this surface is bounded in its anterior half by a linear elevation called the *tænia thalami.* This surface is subdivided by an oblique groove corresponding to the lateral margin of the body of the fornix into a lateral and a medial portion. The lateral portion forms the floor of the central part of the lateral ventricle. The medial portion is covered by the tela chorioidea of the third ventricle. The *inferior surface* overlies the dorsal part of the cerebral peduncle. The *medial surface* forms the lateral wall of the third ventricle and is connected with the medial surface of the opposite thalamus by a soft mass of grey matter, called the *massa intermedia.* The *lateral surface* lies against a band of white fibres called the internal capsule. The *anterior end* points forwards and medialwards. It approaches its follow of the opposite side and presents an elevation called the *anterior tubercle* which forms the posterior boundary of the interventricular foramen. The *posterior end* projects backwards and lateralwards. It diverges from its fellow of the opposite side and ends in a tubercle called the *pulvinar.* Beneath the pulvinar is a small pea-like oval swelling called the *medial geniculate body.* Below and lateral to the pulvinar is another oval swelling called the *lateral geniculate body.*

The **Pineal Body** (Fig. 92) is a small conical, reddish body placed beneath the splenium of the corpus callosum and above and between the upper pair of corpora quadri-

Fig. 92.—The medulla oblongata, mesencephalon and thalamencephalon (Cunningham).



A. Anterior cornu of lateral ventricle.
B. Septum pellucidum.
C. Column of fornix.
D. Interventricular foramen.
E. Stria terminalis.
F. Massa Intermedia.
G. Posterior commissure.
H. Stalk of the pineal body.
I. Pineal body.
J. Pulvinar.
K. Mesencephalon.
L. Lingula.
M. Brachium conjunctivum.
N. Brachium pontis.
O. Restiform body.
P. Medulla oblongata.
Q. Clava.
R. Trochlear nerve.

gemina. It is covered by a fold of pia mater derived from the inferior layer of the tela chorioidea of the third ventricle. Its apex is directed backwards and its base which looks forwards is fixed by means of a stalk or peduncle. The *stalk* divides into a ventral and a dorsal part. The ventral part becomes continuous with a transverse band of white fibres lying underneath the pineal body called the posterior commissure. The dorsal part divides and is prolonged on each thalamus to be continuous with the tænia thalami. Between the ventral and dorsal parts of the stalk is a recess called the *pineal recess*.

The *posterior commissure* is a transverse band of white fibres which stretches across the upper end of the cerebral aqueduct. It lies behind the third ventricle and the pineal body lies over it.

The *anterior commissure* is a rounded bundle of white fibres which lies transversely just in front of the columns of the fornix. It will be subsequently seen that its fibres can be traced downwards and backwards into the temporal lobe.

The **Third Ventricle** (Fig. 92) is the deep, narrow interval between the two thalami and reaches down to the base of the brain. Its *roof* is formed by the epithelial layer which lines the undersurface of the tela chorioidea and the chorioid plexus of the third ventricle. Its *floor* is formed by certain parts found in the interpeduncular fossa at the base of the brain, viz., the tuber cinereum with the infundibulum and hypophysis, the corpora mamillaria, and the posterior perforated substance. Besides these structures the floor is formed more posteriorly by the tegmenta of the cerebral peduncles. The *anterior boundary* is formed by the lamina terminalis and the anterior commissure. The *posterior boundary* is formed by the posterior commissure and the pineal body.

The *lateral wall* is formed above by the medial surface of the thalamus and below by a lamina of grey matter which passes upwards from the base of the brain. The third ventricle communicates in front with the lateral ventricles through the interventricular foramina and behind with the fourth ventricle through the cerebral aqueduct, the opening of which is seen just beneath the posterior commissure. A shallow groove, called the *hypothalamic sulcus*, extends along the lateral wall from the interventricular foramen to the opening of the cerebral aqueduct and indicates the lower limit of the medial surface of the thalamus.

Recesses of the third ventricle.—Five recesses or small diverticula are seen in the third ventricle. In the anterior wall these are : the *optic recess* which lies above the optic chiasma at the junction of the anterior wall with the floor of the ventricle; and the *vulva* which lies above the anterior commissure. In the floor a funnel-shaped recess, called the *recessus infundibuli* is seen to project into the infundibulum. In the posterior wall there are two recesses : the *pineal recess* which passes into the stalk of the pineal body above the posterior commissure ; and the *suprapineal recess* which lies above the pineal body —the wall of this diverticulum is formed by a prolongation of the epithelium of the roof of the ventricle.

The *trigonum habenulæ* is a triangular depression lying between the posterior part of the pineal stalk and the medial surface of the posterior part of the thalamus. Behind it is the superior colliculus of the corpora quadrigemina. It contains a collection of nerve-cells called the *ganglion habenulæ*.

THE MESENCEPHALON OR MID-BRAIN.

The Mid-Brain connects the cerebral hemispheres

above with the pons and cerebellum below. It consists of the cerebral peduncles lying ventrally and four rounded bodies called the corpora quadrigemina lying dorsally. It is traversed by a minute canal called the cerebral aqueduct.

The **Cerebral Peduncles** are two thick bundles of white fibres which emerge from the upper surface of the pons and diverge from each other to enter the inferior surface of the cerebral hemispheres. Each peduncle presents four surfaces. The ventral surface is crossed in front by the optic tract. The dorsal surface is surmounted by the corpora quadrigemina. The medial surface bounds the interpeduncular fossa and presents a groove, called the *oculomotor sulcus*, from which the oculomotor nerve emerges. The lateral surface presents a groove called the *lateral sulcus* and is crossed in front by the optic tract and behind by the trochlear nerve. The sulci on the medial and lateral surfaces mark the subdivision of each peduncle into a ventral part called the *base* and a dorsal part called the *tegmentum*.

The **Corpora Quadrigemina** (Fig. 92) are two pairs of rounded eminences composed of grey substance with a coating of white substance on the surface. They are situated on the dorsal aspect of the mid-brain. The upper pair called the *superior colliculi*, are oval in shape and larger than the lower pair, called the *inferior colliculi*, which are rounded. A cruciate groove separates the four eminences from each other. The longitudinal limb of the cruciate groove lies along the median line and ends above in a depression in which the pineal body lies. The lower end of the longitudinal limb terminates in a narrow white band, called the *frenulum veli*, which is continuous with a lamina called the anterior medullary velum. This lamina forms the upper part of the roof of the fourth ventricle. From each colliculus a white band or *brachium*

passes upwards and forwards towards the geniculate bodies. The *superior brachium* passes upwards, for-

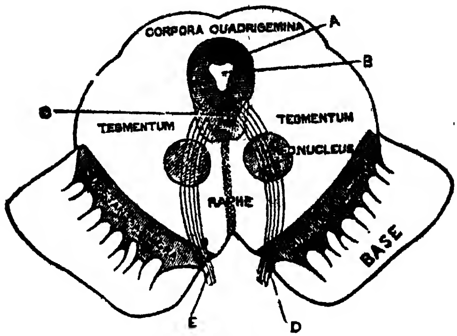


Fig. 98.—Diagram showing the cut surface of the mesencephalon when transversely divided (Cunningham).

A. Central grey stratum.
B. Cerebral aqueduct.
C. Median longitudinal fasciculus.
D. Sulcus oculomotorius.
E. Oculomotor nerve.

wards and lateralwards between the median geniculate body and the pulvinar and divides into two parts; one of which enters the lateral geniculate body and the other is continuous with the optic tract. The *inferior brachium* passes upwards and forwards and ends beneath the median geniculate body.

Optic Tracts.—The terminations (central connections) of the optic tracts may now be conveniently traced. These tracts have been traced from the optic chiasma to the lateral surfaces of the cerebral peduncles. Reaching the dorsal aspect of the lateral surface of the peduncle each tract divides into a medial and a lateral root. The *medial root* terminates in the medial geniculate body. The *lateral root* breaks up into three parts: one part ends in the pulvinar, the second in the lateral geniculate body,

and the third reaches the superior colliculus through the superior brachium of the corpora quadrigemina.

Divide the mid-brain transversely at the level of the lower border of the superior colliculi. On the cut surface the dissector will notice (1) the divided cerebral aqueduct, (2) a mass of dark, pigmented grey substance called the substantia nigra, separating (3) the dorsal portion of the cerebral peduncle termed the tegmentum, from (4) its ventral part called the base.

The **Cerebral Aqueduct** (Aqueduct of Sylvius) is a narrow canal, about half an inch in length, leading from the fourth to the third ventricle. It is placed nearer the dorsal than the ventral surface of the mid-brain. It is surrounded by a layer of grey substance called the *central grey stratum* in which are situated the nuclei of the oculomotor and trochlear nerves and the nucleus of the mesencephalic root of the trigeminal nerve.

The **Substantia Nigra** (Fig. 93) is a crescentic mass of dark pigmented grey substance lying between the tegmentum and the base of the cerebral peduncle. It extends from the upper part of the pons to the subthalamic region. Its dorsal surface is concave and ventral surface convex. From the ventral surface processes project into the substance of the base of the peduncle. Its medial end is thick and lies against the oculomotor sulcus. Its lateral end lies against the lateral sulcus.

The **Base of the Peduncle** (crusta or pes) (Fig. 93) is semilunar on transverse section and made up of longitudinal bundles of white fibres. These bundles may be divided into three main parts. (1) The fibres occupying the lateral fifth of the base, called the *temporo-pontine fibres*, begin from the temporal lobe of the hemisphere and end in the pons. (2) The fibres occupying the middle three-fifths of the base, called the *cerebrospinal fibres*, begin from the motor area of the cortex and proceed

through the pons and the medulla oblongata to the medulla spinalis. (8) The fibres occupying the medial fifth of the base, called the *frontopontine fibres*, begin from the frontal lobe and end in the pons.

The **Tegmentum** (Fig. 98) of one side is continuous with that of the opposite side in the median plane. It is composed of grey and white substance. The latter consists of longitudinal fibres separated by transverse fibres. It thus forms a reticulated structure which is similar to the reticular formation of the medulla oblongata and the pons of which it is the upward prolongation. If a section is made through the mesencephalon of a fresh brain the dissector will see that most of the longitudinal fibres are arranged into well defined tracts, viz., the medial longitudinal fasciculus, (2) the brachium conjunctivum, and (3) the lemniscus.

The *medial longitudinal fasciculus* is a small tract placed in the floor of the cerebral aqueduct on either side of the middle line.

The *brachium conjunctivum* (superior cerebellar peduncle) issues from the cerebellum and passes upwards to the inferior colliculus beneath which it disappears. As it passes upwards it approaches its fellow of the opposite side. The fibres of the brachia then proceed taking a deeper course and decussate with each other. The brachia of the two sides are joined to each other at the lower part by a thin lamina called the *anterior medullary velum*, with which they form part of the roof of the fourth ventricle.

The *lemniscus* (fillet) is a tract of longitudinal fibres which passes upwards through the ventral part of the tegmentum. It is divisible into two parts, medial and lateral, having different origins and terminations. The *medial lemniscus* consists of sensory fibres most of which terminate above in the thalamus. The *lateral lemniscus*

is the lateral portion which is bent backwards and reaches the surface of the mid-brain at the upper part of the lateral sulcus. This tract contains fibres derived mainly from the nucleus of the cochlear division of the acoustic nerve and terminates in the inferior colliculus and median geniculate bodies.

Red Nucleus.—If the cerebral peduncle is divided through the superior colliculi a rounded, reddish grey mass will be seen. This is the red nucleus. It lies in the upper part of the tegmentum beneath the thalamus. Most of the fibres of the brachium conjunctivum terminate in it.

THE BASAL GANGLIA AND INTERNAL CAPSULE.

Separate the two hemispheres from each other by a sagittal section exactly through the median plane. This section should pass through the genu of the corpus callosum and through the cavity of the septum pellucidum. The anterior commissure should be divided and the body of the fornix separated into two halves. The massa intermedia, the posterior commissure and the pineal body should be divided in the median line. At the base of the brain the section should pass through the centre of the optic chiasma backwards between the corpora mamillaria. From the remains of the right cerebral hemisphere remove a slice by a horizontal section at the level of the interventricular foramen. On the surface of this section a bent tract of white substance, called the internal capsule, will be seen with the concavity turned lateralwards. In the concavity of the bend will be seen a biconvex lens-like, grey mass called the lentiform nucleus. On the medial side of the internal capsule, the sections of the caudate nucleus and the thalamus will be seen. On the lateral side of the

lentiform nucleus another thin layer of white substance, called the external capsule, will be seen. Lateral to that a thin layer of grey substance called the claustrum, will be noticed. Lateral to that is the section of the insula with a lamina of white substance in the centre and convoluted grey substance on the surface. These parts should now be studied in detail.

The **Basal Ganglia** are the corpus striatum, the claustrum, and the amygdaloid nucleus.

The **Corpus Striatum** is a large mass of grey substance situated in front of and to the lateral side of the thalamus. Part of it has been seen projecting into the lateral ventricle when this cavity was opened. This portion is called the intraventricular portion or the caudate nucleus, while the remaining portion of it is embedded in the white substance of the cerebral hemisphere and is called the extraventricular portion or lentiform nucleus.

The **Caudate Nucleus** is a pear-shaped mass of grey substance. It presents a broad anterior extremity or *head* which projects into the anterior cornu of the lateral ventricle and a narrow tapering posterior extremity or *tail* which lies on the lateral side of the thalamus and is prolonged downwards along the roof of the inferior cornu to terminate at the amygdaloid nucleus. It is separated in the greater part of its extent from the lentiform nucleus by a thick layer of white substance, the internal capsule, but is continuous with that nucleus in front.

The **Lentiform Nucleus** as seen on the surface of the section, is a biconvex mass of grey substance. It is broader above than below. It is bounded laterally by a thin layer of white substance called the *external capsule* and medially by the internal capsule in the concavity of which it lies. It is continuous above and in front with the head of the caudate nucleus and below with the anterior perforated substance. The substance of the

lentiform nucleus is subdivided into three segments by two antero-posterior vertical laminæ of white substance called the medullary laminæ. Of these three segments the medial two are of a lighter colour being mixed up with white fibres and are together called the *globus pallidus.* The lateral segment is of a darker colour and is called the *putamen.*

The **Claustrum** is a thin lamina of grey substance lying between the external capsule medially and the white matter of the insula laterally. Its medial surface is concave. Its lateral surface is convex and irregular and adapted to the gyri and sulci of the insula. It is narrow above and broad below, where it is continuous with the anterior perforated substance.

The amygdaloid nucleus has been already described.

Take the remains of the left cerebral hemisphere and break off the gyri of the insula and gradually proceed medialwards till the external capsule is removed and the lateral surface of the lentiform nucleus is exposed. Define the continuity of the lentiform and caudate nuclei anteriorly. When the lentiform nucleus has been well defined try to isolate it from the internal capsule lying medially. In suitably hardened specimens the lentiform and caudate nuclei and the thalamus can be, if care is taken, isolated from the internal capsule. If another cerebral hemisphere is available an attempt should be made to show the continuity of the internal capsule through the corpus callosum to the cerebral cortex. The gyri are to be broken off with the fingers and the radiating fibres of the internal capsule (corona radiata) to the cortex of the brain are to be defined.

The **Internal Capsule** is a broad band composed of white fibres, lying between the lentiform nucleus laterally and the caudate nucleus and thalamus medially. In horizontal section it presents a bend called the genu the

convexity of which projects between the caudate nucleus and the thalamus. The anterior limb of the genu is called the frontal part and its posterior limb, the occipital part of the internal capsule. The *frontal part* of the internal capsule contains (1) fibres passing upwards from the thalamus to the frontal lobe, (2) fibres passing from the corpus striatum to the cortex, and (3) fronto-pontine fibres, which pass from the frontal lobe through the medial fifth of the base of the cerebral peduncle to the pons. The *genu* contains fibres which arise from the motor area of the cortex and are called the geniculate fibres. The anterior two-thirds of the *occipital part* of the internal capsule contain cerebro-spinal fibres which originate from the motor area of the cortex and occupy together with the geniculate fibres the middle three-fifths of the base of the cerebral peduncle. The posterior third of the occipital part of the internal capsule contains sensory fibres (1) from the thalamus, (2) from the lower visual centres to the cortex of the occipital lobe (fibres of optic radiation), and (3) from the lateral lemniscus to the temporal lobe (fibres of acoustic radiation). If the fibres of the internal capsule are traced upwards they are seen to diverge in a fan-like manner forming the *corona radiata* and reach the cortex of the brain. The fibres of the frontal part of the internal capsule are connected with the cortex of the frontal lobe; those of the genu and the anterior two-thirds of the occipital part with the motor area of the cortex; those of the posterior third of the occipital part with the parietal, temporal and occipital regions of the cortex. Traced below the fibres of the internal capsule are continuous with the base of the cerebral peduncle.

The **External Capsule** is a thin lamina of white substance situated between the lentiform nucleus medially and the claustrum laterally. It is continuous

in front, behind and above with the internal capsule.

The columns of the fornix should now be traced to their terminations in the corpora mamillaria by removing the ependyma covering them in the lateral walls of the third ventricle. Each column passes downwards and backwards and terminates in the mamillary body at the base of the brain.. On trying to detach the mamillary body a bundle of white fibres called the thalamomamillary fasciculus (bundle of Vicq d'Azyr) will be seen passing upwards and backwards to the anterior part of the thalamus.

The *anterior commissure* should now be traced to its termination. It has been seen to form the anterior boundary of the third ventricle and to lie in front of the columns of the fornix. Thence it passes on either side lateralwards, backwards and downwards and can be traced to enter the temporal lobe.

MEDULLA SPINALIS.

The medulla spinalis which was put in preserving fluid should now be studied so that the continuity of its parts with those of the medulla oblongata may be examined.

Attachment of Spinal Nerve-Roots.—The *anterior* or *motor root* is attached to the antero-lateral aspect of the medulla spinalis by several fila which spread over a wide area and are arranged in two or three linear rows. The *posterior* or *sensory root* is attached by several fila into a linear longitudinal groove in the posterolateral aspect of the medulla spinalis. This groove is called the posterolateral sulcus.

Fissures and Sulci.—The *antero-median fissure* lies vertically along the median line on the anterior surface

The *posteromedian sulcus* lies vertically on the posterior surface of the medulla spinalis along the median line.

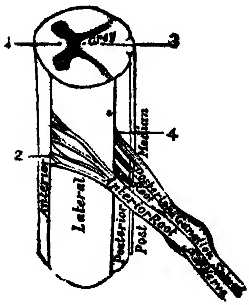


Fig. 94.—Sideview of the medulla spinalis (Gray).

Grey.—Grey substance.
Anterior.—Anterior funiculus.
Lateral.—Lateral funiculus.
Posterior —Posterolateral funiculus.
Post-median —Posteromedian funiculus.
1. Anteromedian fissure.
2. Attachment of anterior root.
3. Posteromedian fissure.
4. Posterolateral fissure.

It is very shallow and from its bottom a septum of neuroglia tissue, called the postero-median septum, passes into the substance of the medulla spinalis. Another groove, called the *posterolateral sulcus*, lies on either side of the posteromedian sulcus and gives attachment to the fila of the posterior nerve-roots.

Regions of the Medulla Spinalis.—By these three sulci the surface of each half of the medulla spinalis is divided into two regions: (1) the *anterolateral region* which lies between the anteromedian fissure and the posterolateral sulcus; (2) the *posterior funiculus* which lies between the posteromedian and posterolateral sulci. Each of these regions is again subdivided into two parts. Thus the anterolateral region is subdivided into the *anterior* and *lateral funiculi* by the line of attachment of the most lateral fila of the anterior nerve-roots. The posterior funiculus is subdivided by a faint groove, called the *postero-intermediate sulcus*, into the posteromedian funiculus (column of Gall) which lies between the postero-median and postero-intermediate sulci and the *postero-lateral funiculus* (column of Burdach) which lies between the postero-intermediate and posterolateral sulci. It

should be noted that the postero-intermediate sulcus which lies between the posteromedian and posterolateral sulci can be traced only in the cervical and thoracic regions.

Make a thin transverse section of the medulla spinalis, place it on a glass slide and hold it on to the light. From this section the structure of the medulla spinalis can be to a great extent studied with the naked eye.

Internal Structure of the Medulla Spinalis.—The medulla spinalis consists of white nervous substance externally and grey substance internally. In a transverse section the grey substance presents the appearance of two comma-shaped masses, the convexities of which are directed towards each other. These are connected together by a transverse band of grey substance called the *grey commissure.* These masses together with the transverse grey commissure present the shape of the letter H. Through the grey commissure a minute canal, called the *central canal,* runs throughout the entire length of the medulla spinalis. It is closed below and continuous above with the central canal of the medulla oblongata. The portion of the grey commissure lying in front of the central canal is called the *anterior grey commissure* and that behind it is called the *posterior grey commissure.* The posteromedian septum reaches the posterior grey commissure but the bottom of anteromedian fissure is separated from the anterior grey commissure by a band of white substance called the *anterior white commissure.*

Each comma-shaped mass of grey substance is divisible into an anterior column lying in front of the grey commissure and a posterior column lying behind it. The *anterior grey column* (anterior cornu) is short, thick and rounded and is separated from the surface of the spinal medulla by white substance through which the fila of the anterior nerve-roots pass to the surface. Its enlarged

extremity is called the *head* and the posterior constricted portion is called the *base*. In sections of the thoracic portion of the medulla spinalis another column is seen projecting lateralwards from the base of the anterior column. This is called the *lateral column*. The *posterior column* (posterior cornu) is long and narrow; it presents a slight enlargement near the posterolateral sulcus called the *head*. The head tapers to a pointed extremity called the *apex* with which the fila of the posterior nerve roots are continuous. In front of the head is a slight constriction called the *neck* and in front of the neck is the *base* which is continuous with the base of the anterior column. Surrounding the apex of the posterior grey column is a translucent mass called the *substantia gelatinosa of Rolando*. The variations in the shape and size of the grey substance in different regions should be noted, by making thin transverse sections therefrom.

The white substance of the medulla spinalis is subdivided into three funiculi: anterior, lateral, and posterior, corresponding to the three regions on the surface. In the *anterior funiculus* there is an important fasciculus called the *fasciculus cerebrospinalis* (direct pyramidal tract) which lies on either side of the anteromedian fissure. In the *lateral funiculus* there are three important fasciculi: (1) the *fasciculus spinocerebellaris* (direct cerebellar tract) which lies superficially at the back part of the lateral funiculus; (2) the *superficial anterolateral fasciculus* (of Gowers) which also lies superficially in front of the former fasciculus; (3) the fasciculus *cerebrospinalis lateralis* (crossed pyramidal tract) which lies between the fasciculus spinocerebellaris and the posterior grey column. These fasciculi cannot be identified with the naked eye. In the upper cervical region the fila of the spinal nerve roots of the accessory nerve pass through the lateral funiculus. In the *posterior funiculus* there

are two fasciculi: (1) the *fasciculus gracilis* (Goll's) which lies posteromedially and (2) the *fasciculus cuneatus* (Burdach's) which lies posterolaterally. These two fasciculi can be indentified in thin sections with the naked eye. They are separated from each other by the postero-intermediate sulcus.

HIND-BRAIN.

The hind brain (Rhombencephalon) consists of the medulla oblongata, the pons, and the cerebellum including the fourth ventricle and the isthmus rhombencephali.

The **Medulla Oblongata** (Fig. 95) extends from the lower margin of the pons to the lower margin of the foramen magnum at which level it becomes continuous with the medulla spinalis. It is a little more than an inch in length, three fourths of an inch wide at its broadest part, and half an inch in thickness. Its ventral surface rests in the groove on the basilar portion of the occipital bone. Its dorsal surface lies in the depression between the hemispheres on the cerebellum and forms the lower part of the floor of the fourth ventricle. The anteromedian and posteromedian fissures of the spinal medulla are continued into the medulla oblongata and divide it into two symmetrical halves.

Fissures on the surface of the medulla oblongata.—The *anteromedian fissure* is interrupted at its lower part by some bundles of fibres crossing from one side to the other. This intercrossing of fibres is called the *pyramidal decussation.* This fissure ends above at the lower border of the pons in a cul-de-sac called the *foramen cæcum.* The *posteromedian fissure* is continued upwards to about the middle of the medulla oblongata and ceases at the lower end of the fourth ventricle. The attachment of the roots of the hypoglossal nerve marks

the position of a faint groove called the *anterolateral sulcus.* The attachment of the roots of the glossopharyngeal, vagus, and accessory nerves in a line indicates the position of another faint groove called the *posterolateral sulcus.*

Regions of the medulla oblongata.—The surface of each half of the medulla oblongata in subdivided into three regions, anterior, posterior, and lateral by the anterolateral and posterolateral sulci.

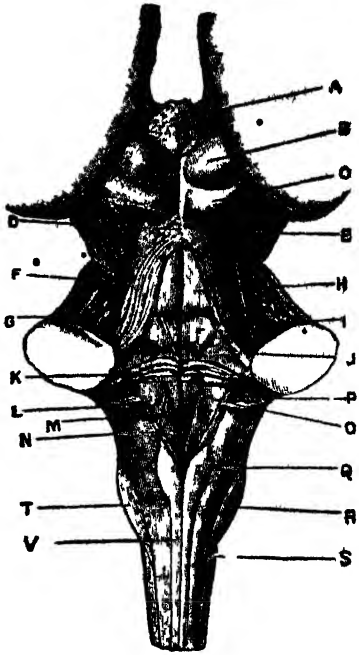
The **Anterior Region** or **Pyramid** constitutes that portion of the medulla oblongata which is included between the anteromedian fissure and the anterolateral sulcus. It is narrow below but it expands as it passes upwards and again becomes constricted at the lower border of the pons and enters into that structure. At the lower part the fibres of the medial two-thirds of the pyramid cross to the opposite side forming the *pyramidal decussation.* This decussation can be easily verified at the bottom of the anteromedian fissure by separating its lateral margins. The remaining lateral third of the pyramid is continued down into the anterior funiculus of the medulla spinalis on the same side as the fasciculus cerebrospinalis.

The **Lateral Region** is situated between the anterolateral sulcus containing the roots of the hypoglossal nerve and the posterolateral sulcus containing the roots of the glossopharyngeal, vagus, and accessory nerves. In the lower part of the medulla oblongata it appears as a continuation of the lateral funiculus of the spinal medulla ; but in its upper part, it lies hidden by a conspicuous oval-shaped eminence called the *olive.* Behind the olive and between it and the posterolateral sulcus is seen an attenuated continuation upwards of the lateral region. The olive is about half an inch in length and separated from the lower border of the pons by a groove

where the facial nerve is attached. Covering its surface are some arched fibres called the *external arcuate fibres*

Fig. 95.—Dissection of the fourth ventricle of the brain (Cunningham).

A. Pineal body.
B. Superior colliculus.
C. Inferior colliculus.
D. Anterior medullary velum.
E. Cerebral peduncle.
F. Brachium conjunctivum.
G. Brachium pontis.
H. Pontine part of floor of fourth ventricle.
I. Colliculus facialis.
J. Fovea superior.
K. Stria medullaris.
L. Area acustica.
M. Fovea inferior.
N. Ala cinerea.
O. Trigonum hypoglossi.
P. Restiform body.
Q. Clava.
R. Tuberculum cinereum.
S. Fasciculus cuneatus.
T. Cuneate tubercle.
V. Fasciculus gracilis



which emerge from the anteromedian fissure and curve backwards over it to enter the restiform body.

The **Posterior Region** is included between the posteromedian fissure and the posterolateral sulcus. At its lower part it is subdivided into three smaller funiculi by slight furrows. The medial funiculus is close to the posteromedian fissure and is called the *fasciculus gracilis.* It terminates in the lower part of the fourth ventricle in an expanded elevation called the *clava* beneath which is a nucleus of grey matter called the *nucleus gracilis.* Lateral to the fasciculus gracilis is the *fasciculus cuneatus.*

It also ends in the lower part of the fourth ventricle in an elevation, called the *cuneate tubercle,* which overlies a nucleus of grey matter called the *nucleus cuneatus.* These two fasciculi are the continuations of the same in the posterior funiculus of the medulla spinalis. Lateral to the fasciculus cuneatus is the *fasciculus of Rolando* which is narrow below and expanded above forming the *tubercle of Rolando.* It is caused by the substantia gelatinosa of Rolando and is covered on the surface by the spinal tract of the trigeminal nerve. At the upper part of the medulla oblongata the posterior region is occupied medially by the lower part of the fourth ventricle and laterally by two thick diverging fasciculi called the *restiform bodies.* These restiform bodies appear to be formed by the continuations upwards and lateralwards of the fasciculus gracilis and fasciculus cuneatus together with the fasciculus of Rolando. But in reality the gracilis and cuneate fasciculi terminate in their respective nuclei already referred to. The restiform bodies (inferior peduncles of the cerebellum) finally pass backwards and enter the cerebellum. They contain mainly (1) the cerebellospinal fibres from the lateral funiculi of the spinal medulla and (2) the external arcuate fibres which enter them by curving backwards over the olive.

The **Pons** (Pons varolii) (Fig. 89) is the connecting link between the cerebrum above, the medulla oblongata below and the cerebellum behind. Its *superior surface* is attached to the mid-brain. Its *inferior surface* is continuous with the medulla oblongata. Its *ventral* or *anterior surface* is convex and consists of transverse fibres; these are gathered together on each side into a compact mass, which enters the cerebellum and is termed the brachium pontis (middle peduncle of the cerebellum). The trigeminal nerve is attached to this surface near its upper border and the brachium pontis is the portion

which lies lateral to this attachment. This surface rests on the clivus of the sphenoid and presents a shallow median groove, *sulcus basilaris,* along which the basilar artery runs. The *dorsal* or *posterior surface* forms the upper part of the floor of the fourth ventricle and will be subsequently described.

The **Cerebellum** is situated behind the medulla oblongata and the pons and beneath the occipital lobes of the cerebrum. It is covered externally by grey substance which is darker than that of the cerebrum. The white substance occupies its interior. Its surface is not mapped out by tortuous convolutions like those of the cerebrum, but it consists of a large number of thin laminæ which are separated by numerous parallel curved sulci.

The cerebellum consists of two lateral parts called the *hemispheres* and a median part called the *vermis.* The part of the vermis which lies on the upper surface of the cerebellum is called the *superior vermis*; and the part on the lower surface, the *inferior vermis,* which is lodged in a deep median fossa between the hemispheres called the *vallecula.* The hemispheres are separated below and behind by a deep notch called the *posterior cerebellar notch* into which the falx cerebelli is received. Above and in front they are separated by a broad and shallow notch called the *anterior cerebellar notch* which receives the inferior colliculi.

Superior Surface of the Cerebellum.—The fissures and lobules on the superior vermis are continuous with those on the superior surface of the hemispheres. The fissures have the same names both on the vermis and the hemispheres, but the lobules are differently named. Thus on the superior surface of the vermis there are five lobules. Commencing from the front these are: the lingula, the central lobule, the culmen monticuli, the clivus monticuli and the folium vermis. The lingula has no

corresponding lobule on the superior surface of the cerebellar hemisphere. The remaining four lobules of

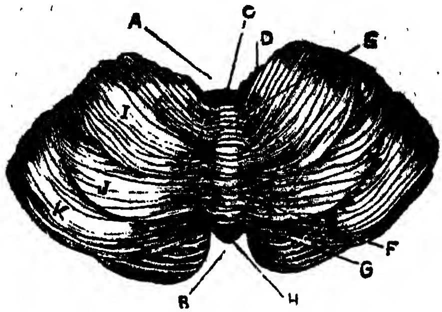


Fig. 96.—Superior surface of the cerebellum.

A. Anterior cerebellar notch.
B. Posterior cerebellar notch.
C. Lobulus centralis.
D. Ala lobuli centralis.
E. Culmen monticuli.
F. Clivus monticuli.
G. Folium vermis.
H. Tuber vermis.
I. Anterior part of quadrangular lobe.
J. Posterior part of quadrangular lobe.
K. Superior semilunar lobule.

the superior vermis have corresponding lobules on the hemispheres. These are from before backwards: the ala lobulus centralis, the anterior crescentic lobule, the posterior crescentic lobule, and the postero-superior lobule. The *lingula* consists of four of five folia prolonged from the vermis on to the surface of the anterior medullary velum. The *lobulus centralis* is separated from the lingula by the *precentral fissure* and is continuous laterally with the ala lobulus centralis. The *culmen monticuli* is the most prominent part of the superior vermis. It is separated from the lobulus centralis by the *postcentral fissure.* Laterally it is continuous with the anterior crescentic lobule on the hemisphere. The *clivus monticuli* is on the slope of the monticulus and is separated from the culmen by the *preclival fissure* which is prolonged

laterally on the hemisphere behind the anterior crescentic lobule. Laterally the clivus is continuous with the posterior crescentic lobule. The culmen and clivus are together called the monticulus. The anterior and posterior crescentic lobules are included under one name, the quadrangular lobule. The *folium vermis* (folium cacuminis) is the posterior end of the superior vermis separated from the clivus by the postclival fissure. Laterally it is continuous with the postero-superior lobule on the hemisphere.

The *horizontal sulcus* is the most conspicuous fissure in the cerebellum. It begins in front at the pons, and passing backwards round the lateral and posterior borders of each hemisphere, dips down into the posterior cerebellar notch. It divides the cerebellum into an upper and a lower part demarcating the superior from the inferior surface.

Inferior Surface of the Cerebellum.—Both the inferior vermis and the inferior surface of the cerebellar hemispheres are subdivided into lobules by fissures. But the continuity of the lobules of the inferior vermis with those on the inferior surface of the hemispheres is not so marked as on the superior surface. The lobules on the inferior vermis from before backwards are: (1) the nodule, (2) the uvula, (3) the pyramid, and (4) the tuber vermis. The lobules on the inferior surface of the hemispheres are: (1) the flocculus, (2) the tonsilla cerebelli, (3) the biventer lobule, and (4) the postero-inferior lobule. The fissures separating the lobules of the inferior vermis are (1) the *postnodular fissure* which separates the nodule from the uvula. It passes lateralwards into the hemisphere separating the flocculus in front from the tonsil and biventral lobule behind and joins the anterior end of the horizontal sulcus. (2) The *prepyramidal fissure* separates the uvula from the pyramid on the inferior vermis. On the hemisphere it curves

forwards round the tonsil between it and the biventral lobe to join the postnodular fissure in front. (3) The

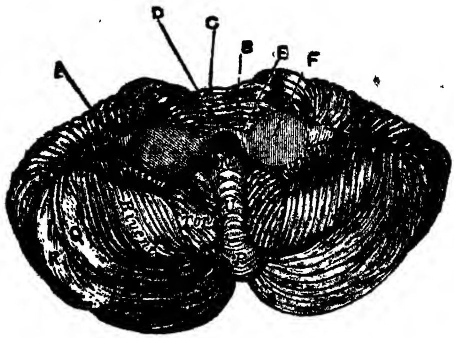


Fig. 97.—Inferior surface of the cerebellum.

A. Flocculus.
B. Ala lobuli centralis.
C. Lobulus centralis.
D. Anterior medullary velum.
E. Brachium conjunctivum.
F. Brachium pontis.
N. Nodule.
P. Pyramid.
Q. } Inferior semilunar lobule.
R. }
U. Uvula.

postpyramidal fissure separates the pyramid from the tuber vermis and passes lateralwards behind the tonsil and biventral lobule and in front of the postero-inferior lobule to join the horizontal sulcus. The *nodule* is connected with the flocculus laterally by a thin layer of white substance emerging from the cerebellum called the *posterior medullary velum*. The *flocculus* lies against the brachium pontis. These three parts, viz., the nodule, the posterior medullary velum, and the flocculus constitute the *lobus noduli*. The *uvula* is connected with the tonsils on either side by a narrow ridge of grey matter marked with furrows on the surface, called the *furrowed band*. The uvula, the furrowed band, and the tonsil constitute the *lobus uvulæ*. The *pyramid* is connected

on either side with the biventral lobule by a grey band which lies across the sulcus vallecula. The pyramid, the grey band, and the biventral lobule constitute the *lobus pyramidis*. The *tuber vermis* is continuous directly with the postero-inferior lobule; the two lobules are included under one name, the *lobus tuberis*.

Structure of the Cerebellum.—Make a sagittal section through the right cerebellar hemisphere close to the vermis. The cerebellum consists of a central core of white substance with a superficial covering of grey substance.

The central core of white substance is seen to give off thin laminated branches into the interior of the individual folia or laminæ which are provided with superficial coating of grey substance. These radiating white branches from the central core of white substance present the appearance of a branching tree. This characteristic appearance is called the *arbor vitæ*. In the central core of white substance a folded lamina of grey substance is found called the *dentate nucleus*. Its wall has a wavy outline. Its open mouth or hilum is directed forwards and medialwards through which white fibres pass. Its opposite end is blind. In addition to the dentate nucleus there are other minute nuclei of grey substance. Thus there are two nuclei close to the hilum of the dentate nucleus, called the *nucleus emboliformis* and the *nucleus globosus*. A third nucleus is seen in the roof of the fourth ventricle and is called the *nucleus fastigii*. These nuclei cannot be easily demonstrated with the naked eye.

Make a sagittal section through the superior vermis exactly in the median line. The roof of the fourth ventricle is thus divided. On separating the cerebellar hemispheres the floor of the fourth ventricle is exposed.

Connections of the Cerebellum.—The cerebellum is connected with the cerebrum, the pons, and the medulla

oblongata by three bundles of fibres on each side. These are the brachium conjunctivum, the brachium pontis, and the restiform body.

The *brachium conjunctivum* (superior cerebellar peduncle) emerges from the upper part of the cerebellum and forms at first the upper and lateral boundary of the fourth ventricle. Higher up it approaches its fellow of the opposite side and forms the upper part of the roof of the same ventricle. Its further course has been described (p. 488). Most of the fibres of the brachium conjunctivum are derived from the dentate nucleus. The triangular interval between the two brachia conjunctiva below is filled up by the anterior medullary velum.

The *brachium pontis* (middle cerebral peduncle) consists of transverse fibres of the pons which enter the cerebellar hemisphere.

The *restiform body* (inferior cerebellar peduncle) enters the cerebellum between the brachium conjunctivum and the brachium pontis. Its formation has been described (p. 500). Before it enters the cerebellum it is crossed dorsally by strands of white fibres called the *striæ medullares*.

Two other thin laminæ of white substance which emerge from the central core of the cerebellum and assist in forming the roof of the fourth ventricle are now to be examined. They are the anterior and posterior medullary vela.

The *anterior medullary velum* (valve of Vieussens) is the triangular lamina of white substance which issues from the central core of the cerebellum and fills up the gap between the two brachia conjunctiva. It forms the roof of the fourth ventricle and on its dorsal surface lies the lingula of the superior vermis.

The *posterior medullary velum* is a thin lamina of white substance which also emerges from the central white core

of the cerebellum in close contact with the anterior medullary velum. The two vela then diverge; the anterior one passing upwards and the posterior one downwards round the nodule of the inferior vermis. The posterior velum ends below in a thin crescentic margin and connects the nodule with the flocculus. It terminates in a free margin below and the epithelial lining of the fourth ventricle is prolonged downwards from the posterior velum covering the pia mater (tela chorioidea of the fourth ventricle) and forming the roof of the lower part of the same ventricle.

Isthmus rhombencephali.—This name is given to the constricted part of the rhombencephali which lies between the corpora quadrigemina above and the cerebellum below. It is formed by the brachia conjunctiva, the anterior medullary velum, and the upper part of the fourth ventricle.

The **Fourth Ventricle** (Fig. 95) is situated behind the pons and the upper part of medulla oblongata. It presents for examination lateral boundaries, four angles, a roof, and a floor.

The *lateral boundaries* are formed, below, by the clava, the fasciculus cuneatus and the restiform body; above, by the brachium pontis and the brachium conjunctivum.

Angles.—The *superior angle* corresponds to the convergence of the brachia conjunctiva and leads into the cerebral aqueduct. The *inferior angle* leads into the central canal of the medulla oblongata. The *lateral angles* correspond with the junctions of the upper lateral and lower lateral boundaries. Below the lateral angle, the fourth ventricle is prolonged laterally, on either side, over the upper part of the restiform body as a recess called the *lateral recess.*

The *roof* of the fourth ventricle is formed, above, by the brachia conjunctiva and the anterior medullary

velum; below, by the posterior medullary velum; the tela chorioidea of the fourth ventricle lined by ventricular epithelium, the obex, and the tænia of the fourth ventricle. Of these the posterior medullary velum has been described and may now be more fully examined.

The *tela chorioidea of the fourth ventricle* is a triangular layer of pia mater lined by the ventricular epithelium. It forms the roof of the fourth ventricle below the posterior medullary velum. The *chorioid plexus of the fourth ventricle* is a vascular fringe of the tela chorioidea which projects into the ventricular cavity from the roof by pushing the epithelial covering before it. In each half of the cavity, it presents the appearance of a reversed L; the vertical limb of which lies close to the middle line and the horizontal limb passes lateralwards to the end of the lateral recess. There are three openings in the tela chorioidea by means of which the cavity of the fourth ventricle communicates with the subarachnoidean cavity. One of these, the *apertura medialis* (foramen of Magendie), is situated over the inferior angle of the ventricle. The other two, called the apertura lateralis (foramina of Key and Retzius), lie over the ends of the lateral recesses. The *obex* is a thin triangular lamina of grey substance which bridges over the inferior angle of the fourth ventricle from the clava of one side to the other. The *tæniæ of the fourth ventricle* (ligulæ) are two narrow bands of white substance seen, one on either side of the lower part of the roof of the fourth ventricle. The medial margin of each is continuous with the epithelial lining of the tela chorioidea and the lateral margin is attached to the clava and the restiform body below the stria medullaris. Below it is continuous with the obex. It forms the inferolateral limit of the roof of the fourth ventricle.

The *floor* of the fourth ventricle is called the *rhomboid*

fossa from its shape. It is lozenge-shaped and is formed by the dorsal surface of the pons above and the dorsal surface of the upper part of the medulla oblongata below. It is bisected by a vertical median groove, called the *median sulcus.* On either side of this sulcus is an elongated elevation called the *medial eminence* which is limited laterally by a sulcus called the *sulcus limitans.* The rhomboid fossa is traversed at its widest part opposite the lateral recesses by some transverse white fibres, called the *striæ medullares* (striæ acusticæ), which belong to the cochlear division of the acoustic nerve and sink into the median sulcus. Laterally they cross the upper part of the restiform bodies. By these striæ the rhomboid fossa is subdivided into an upper and a lower part.

In the upper part of the rhomboid fossa the medial eminence presents a nodular swelling just above the striæ medullares. This nodular elevation is called the *colliculus facialis* and is caused by the underlying ascending portion of the root of the facial nerve. The sulcus limitans is narrow above where it presents a slaty colour and is called the *locus cæruleus.* It owes its colour to pigmented cells called the *substantia ferruginea* lying underneath. Lateral to the colliculus facialis the sulcus limitans is wide and deep and is called the *superior fovea.* In the lower part of the rhomboid fossa the medial eminence is narrow and triangular and is called the *trigonum hypoglossi* as it overlies the nucleus of the hypoglossal nerve. The sulcus limitans lateral to the trigonum hypoglossi becomes distinctly deep and is called the *inferior fovea.* Lateral to the fovea inferior is another triangular elevation called the *area acustica* which extends to the lateral recess and is crossed superficially by the striæ medullares at its upper part. Below the inferior fovea is a triangular area darker in colour than the rest of the fovea and called the *ala cinerea*

trigonum vagi). This area corresponds to the sensory nuclei of the glossopharyngeal and vagus nerves. Below the ala cinerea is a ridge-like elevation called the *funiculus separans*, which is separated from the clava by a narrow area called the *area postrema*. The inferior angle of the rhomboid fossa is pointed and from its resemblance to a pen is called the *calamus scriptorius*.

On the left side the student should try to trace the restiform body and the brachia pontis and conjunctivum through the cerebellum to investigate their ultimate destination. The laminæ of the hemispheres should be broken and the direction of the fibrous strands followed. The brachium conjunctivum can be traced to the dentate nucleus while the brachium pontis and the restiform body will be seen to spread out into the cerebellar cortex.

Remove the cerebellum by dividing the brachia and the restiform bodies. Note that the cerebrospinal fasciculus which occupies the middle three-fifths of the base of the cerebral peduncle is continued through the pons and losing some fibres appears in the medulla oblongata as the pyramid. While it passes through the pons it produces a bulging on either side of the sulcus basilaris. The continuity of the pyramid with the cerebrospinal fasciculus in the base of the cerebral peduncle should be traced through the pons. Divide the superficial transverse fibres of the pons along the middle line and reflect them laterally till a longitudinal bundle is reached in continuity with the pyramid. This is the *cerebrospinal fasciculus*. Remove this fasciculus. The deep transverse fibres of the pons are seen lying dorsally to the fasciculus. These form the *trapezoid body*. Covering the upper part of the pyramid and the olive some curved transverse fibres are seen. These are the *external arcuate fibres*.

If the deep transverse fibres of the pons are removed

another bundle of longitudinal fibres will be seen on either side of the middle line. This is the *lemniscus*. It contains fibres from the superficial anterolateral fasciculus of the medulla spinalis and the internal arcuate fibres from the nuclei gracilis and cuneatus of the opposite side. In the medulla oblongata it passes dorsal to the pyramid. In the pons it lies dorsal to the trapezoid body. Its position in the mid-brain has been examined.

The medulla oblongata should now be divided at different levels. Its structure can be fully studied from stained microscopic sections. But if a thin section is placed on a glass slide and held on to the light most of the structures described can be identified with the naked eye.

In sections through the olive, the olivary nucleus will be seen. It resembles to some extent the dentate nucleus of the cerebellum being formed by a folded lamina of grey matter with wavy outline. The median raphe with decussation of fibres may be made out.

In sections through the gracilis and cuneate nuclei these nuclei will appear as dark condensed spots.

THE EYEBALL.

As the eyeball is scarcely obtained in a fresh condition in the dissecting-room the student should procure bullock's eyeballs. On account of their larger size they are better than sheeps' eyeballs for purposes of dissection. He should complete his examination of the organ by dissecting a fresh human eyeball which can be procured from the post-mortem room. The fascia bulbi, the remains of the ocular muscles and fat are to be removed with scissors.

The **Eyeball** lies in the orbital cavity surrounded by the fascia bulbi at its back part. It is composed of

segments of two spheres; the posterior or scleral segment forms about five sixths of the eyeball and the anterior or corneal segment forms about one sixth of the globe. The terms *anterior* and *posterior poles* as applied to the eyeball denote the central points of its anterior and posterior curvatures and a line which joins these two poles is called the *optic axis*. An imaginary line drawn midway between the two poles and encircling the eyeball is called the *equator*.

The eyeball consists of three investing tunics and three refracting media. The three tunics are: (1) an outermost tunic formed by the sclera behind and the cornea in front; (2) an intermediate tunic formed from behind forwards by the chorioid, ciliary body, and iris; and (3) an innermost tunic formed by the retina. The three refracting media are: (1) the aqueous humour in front, (2) the crystalline lens in the middle, and (3) the vitreous body at the back part of the interior of the eyeball.

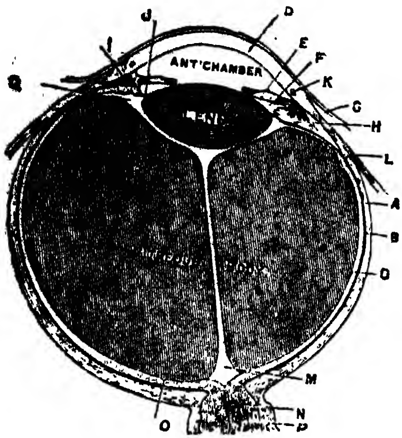
The **Sclera** (sclerotic) is a dense fibrous membrane which occupies the posterior five-sixths of the eyeball and maintains its shape. It is pierced by the optic nerve a little to the medial side of the posterior pole of the eyeball. Here it forms a cribriform lamina, called the *lamina cribrosa*, which presents minute orifices for the passage of the filaments of the optic nerve. One of the orifices occupying the centre of the lamina transmits the central artery and vein of the retina. Around the lamina are many minute apertures for the passage of the posterior ciliary arteries and ciliary nerves. Almost midway between the entrance of the optic nerve and the corneal margin are four or five openings for the exit of veins called the venæ vorticosæ. The front part of the sclera is covered by conjunctiva and near its junction with the cornea (sclero-corneal junction) it is pierced by the anterior

ciliary arteries Close to the sclerocorneal junction there exists in the substance of the sclera a circular canal called the *sinus venosus scleræ* (canal of Schlemn). If a sagittal section is made through another eyeball this sinus is seen as a minute opening at the cut margin of the sclera near the sclerocorneal junction.

Divide the sclera along the equator of the eyeball with the knife taking care that the chorioid tunic lying next to it is not injured. First make an opening in the sclera and then introduce a director through the opening to detach the sclera from the chorioid. Then cut along the equator of the eyeball taking the director as the guide. Note that the inner surface of the sclera is smooth and loosely attached to the chorioid. Note also that an extensive lymph space, called the *spatium perichorioideale,* separates the inner surface of the sclera from the outer surface of the chorioid and that this lymph space is traversed by cellular tissue called the *lamina suprachorioidea.* Remove the posterior segment of the sclera. Note that close to the entrance of the optic nerve the sclera is firmly adherent to the chorioid. Note also that the sclera is much thicker behind than in front.

The **Cornea** forms the anterior sixth of the external tunic. It is transparent and almost circular. Posteriorly its margin is overlapped by the margin of the sclera. Its anterior surface is convex and covered by conjunctiva which is closely adherent to it. Its posterior surface is concave and covered by a very elastic stratum called the *posterior elastic lamina.* At the sclerocorneal junction the posterior elastic lamina breaks up into fibres forming a meshwork and enclosing spaces between them called the *spatia anguli iridis* (spaces of Fontana). Some of these fibres are prolonged on to the surface of the iris forming the *ligamentum pectinatum iridis.* Others are prolonged backwards to the sclera and chorioid.

Fig. 98.—Horizontal section of the bulb of the eye (Cunningham).



A. Sclera.
B. Chorioid.
C. Retina.
D. Cornea.
E. Iris.
F. Posterior chamber.
G. Conjunctiva.
H. Ciliary process.
I. Ciliary muscle.
J. Suspensory ligament of lens.
K. Sinus venosus scleræ.
L. Ora serrata
M. Hyaloid canal.
N. Optic nerve.
O. Macula lutea.
P. Nerve sheath (of dura-mater).

Detach the chorioid with the iris from the sclerocorneal junction by the handle of the scalpel. The ciliary muscle is thus torn and the *vascular tunic* consisting of the chorioid, the ciliary body, and the iris is exposed. Place the eyeball denuded of its external tunic in a tray containing water.

The **Chorioid** is a vascular, darkly-pigmented membrane occupying the posterior five-sixths of the eyeball and is continuous in front with the ciliary body and iris. It is thicker behind than in front. It is pierced behind by the optic nerve. Its outer surface is loosely attached to the sclera by the lamina suprachorioidea. The ciliary nerves run from behind forwards along this surface and look like fine white threads. The ciliary veins converge on this surface to form four or five veins called the *venæ vorticosæ* which are situated along the equator. The inner surface of the chorioid is adherent to the retina.

The Ciliary Body consists of the orbiculus ciliaris, the ciliary processes, and the ciliary muscle.

The *orbiculus ciliaris* forms a zone of about one sixth of an inch in width. It is continuous with the chorioid, lying immediately in front of it. It presents numerous ridges arranged radially.

Make a coronal section through an eyeball at the equator and remove the vitreous body and the lens. Put the specimen in a tray filled with water. The ciliary processes are well seen.

The *ciliary processes* form a circle of elongated ridges, about seventy in number. There are also small ridges which occupy the spaces between the large ridges. They are attached peripherally to the ridges of the orbiculus ciliaris and are therefore continuous with the chorioid. Their opposite ends are directed towards the circumference of the lens.

The *ciliary muscle* consists of unstriated muscle fibres. It is a circular band about one-eighth of an inch in width, situated in front of the chorioid surrounding the circumference of the iris. It consists of two sets of fibres, meridional and circular, which arise from the sclera near the sclerocorneal junction. The meridional fibres pass backwards to be inserted into the orbiculus ciliaris and ciliary processes. The circular fibres form a ring which is inserted around the circumference of the iris.

The **Iris** is a thin muscular curtain situated in front of the lens and behind the cornea. It is circular in shape and its colour varies in different individuals. It is pierced in the centre by a circular aperture called the *pupil.* Two sets of involuntary muscle fibres are found in the iris : (1) the circular fibres which form a band round the pupil called the *sphincter pupillæ* ; (2) the radiating fibres which extend from the sphincter to the circumference

of the iris in a radiating manner and constitute the *dilator pupillæ*.

The **Ciliary Nerves** pierce the sclera around the optic nerve and proceed forwards between the sclera and chorioid as minute white threads till they reach the ciliary zone. Here they form a plexus around the periphery of the iris and supply the ciliary muscle, iris, and cornea.

Ciliary Arteries.—(1) The two *long posterior ciliary arteries* pierce the sclera a little in front of the optic nerve and pass, one on either side, between the sclera and chorioid. Reaching the ciliary zone each divides into an ascending and a descending branch. These branches communicate with each other and form an arterial circle around the periphery of the iris, called the *circulus iridis major*. This circle is joined by the anterior ciliary arteries. From the arterial circle branches proceed towards the pupillary margin and these form a second arterial circle called the *circulus iridis minor*. (2) The *short posterior ciliary arteries* pierce the sclera around the optic nerve and are distributed to the chorioid. (3) The *anterior ciliary arteries* (p. 388) pierce the sclera close to the sclerocorneal junction and join the circulus iridis major.

The student should now proceed to expose the retina fully. Take the specimen which has been divided sagittaly and remove from it the lens and the vitreous body. From the specimen in which the vascular tunic has been exposed, remove the chorioid, the ciliary zone, and the iris.

The **Retina** is the inner most tunic of the eyeball and is formed of nervous substance. It is transparent during life but becomes greyish soon after death. Its outer surface is attached to the chorioid by its pigmentary layer. Its inner surface lies in contact with the hyaloid membrane which covers the vitreous body. Anteriorly the retina becomes thinner and near the ciliary body

presents an irregular wavy margin called the *ora serrata*. Beyond this the nervous elements of the retina cease and its outer pigmentary layer covered by a layer of epithelium is continued forwards over the ciliary processes and the iris forming the *pars ciliaris retinæ* and *pars iridica retinæ*. Posteriorly the retina is firmly adherent at the entrance of the optic nerve. Here the retina presents the appearance of a circular, whitish disc with a slightly raised margin called the *papilla of the optic nerve* (optic disc). The surface of the papilla presents a slight depression called the excavation of the optic nerve. The papilla is pierced in the centre by the central artery and vein of the retina. Exactly in the centre of the retina and directly in the optic axis and about one eighth of an inch to the lateral side of the optic entrance there is a small yellowish spot called the *macula lutea* which has a central depression called the *fovea centralis*. The student will not find macula lutea in the eyeball of the bullock.

The **Refracting Media** are three in number, (1) the aqueous humour, (2) the vitreous body, and (3) the crystalline lens.

The *aqueous humour* occupies the space known as the anterior and posterior chambers. It is transparent and composed of water, holding in solution a very small amount of sodium chloride. The *anterior chamber* is bounded in front by the cornea, behind by the iris and the central part of the lens, and laterally by the ligamentum pectinatum iridis, where a recess is seen called the *iridial angle* (filtration angle) which leads into the spatia anguli iridis. The *posterior chamber* is bounded in front by the iris, behind by the anterior surface of the lens with its suspensory ligament, and laterally by the ciliary processes. The two chambers communicate through the pupil.

In order to expose the vitreous body and the lens take another eyeball, divide its tunics at the equator and

draw the two segments apart. The vitreous body with the lens are expelled in one mass.

The Vitreous Body is a transparent jelly-like mass enclosed in a delicate, transparent membrane called the *hyaloid membrane.* It fills up the posterior four-fifths of the interior of the eyeball. It presents in front a concavity called the *hyaloid fossa* into which the lens is received. A minute canal, called the *hyaloid canal,* runs through the substance of the vitreous body from the region of the optic papilla to the posterior surface of the lens. This canal contains lymph and its wall is formed by a prolongation of the hyaloid membrane. In the embyro it transmits the hyaloid artery to the posterior surface of the lens.

The *hyaloid membrane* encloses the vitreous body. In front of the ora serrata it is distinctly thick and called the *zonula ciliaris* (zonule of Zinn). The zonula presents a series of alternating elevations and depressions to receive the ciliary processes. As it approaches the lens it divides into two layers : (1) a thin lamina which lines the hyaloid fossa behind the lens and (2) a thick layer, called the *suspensory ligament of the lens,* which becomes attached to the capsule of the lens in front. Behind the suspensory ligament and in front of the posterior layer of the zonula ciliaris there is a circular lymph space, called the *spatia zonularia* (canal of Petit) which surrounds the circumference of the lens. This space can be inflated by a fine pointed blow pipe.

The Crystalline Lens is a biconvex, transparent body placed in front of the vitreous body and behind the iris. It is enclosed within a thin transparent membrane called the *capsule of the lens.* It rests in the hyaloid fossa and is retained in that position by the suspensory ligament. Its anterior surface is less convex than the posterior. Its circumference or equator projects into the spatia zonularia.

If the lens is hardened in alcohol the concentric laminæ of which it is composed can be peeled off.

THE SUPERIOR EXTREMITY.

THE BACK.

This dissection includes chiefly an examination of the structures connecting the upper limb to the posterior aspect of the trunk and should be finished in two days. The dissector of the superior extremity begins work on the fourth day after the subject has been brought into the dissecting-room and during the first two days he should work in conjunction with the dissector of the head and neck (See Table on p. 247). The subject is now placed with its face downwards and the arms extended over the sides of the table. Blocks are placed beneath the chest and pelvis.

The dissector of the superior extremity reflects the skin from the back of the thoracic, lumbar, sacral and coccygeal regions by the following incisions (Fig. 52): —(1) A vertical incision from the spinous process of the seventh cervical vertebra along the middle line to the tip of the coccyx; (2) from the lower end of this vertical incision a curved incision upwards, forwards and lateralwards along the crest of the ilium to a point a little behind the anterior superior iliac spine; (3) a third incision from the spinous process of the twelfth thoracic vertebra upwards, forwards, and lateralwards to the acromion. Reflect the flaps of skin lateralwards.

The **Superficial Fascia** is thick and fatty and is a portion of the superficial fascia covering the whole body. In it ramify the cutaneous vessels and nerves. It is

separated from the muscles underneath by a dense fibrous layer which constitutes the **deep fascia.** The latter is continuous with the deep fasciæ of the neighbouring regions.

The **Cutaneous Vessels** and **Nerves** have been fully described on page 262 et seq.

The **Trapezius** (Figs. 53 and 54) has been fully described (p. 248).

The **Latissimus Dorsi** (Fig. 54) is now to be cleaned. It arises (1) from the spinous processes and supraspinous ligaments of the lower six thoracic vertebræ; (2) from the posterior lamella of the lumbodorsal fascia; (3) from the outer lip of the iliac crest a little behind the origin of the obliquus externus abdominis; (4) from the outer surfaces of the lower three or four ribs interdigitating with the origin of the obliquus externus abdominis; and (5) from the dorsal surface of the inferior angle of the scapula. The upper fibres pass horizontally lateralwards; the intermediate ones obliquely upwards and lateralwards; and the lower fibres almost vertically upwards. All the fibres ultimately converge to form a thin flat tendon which turns round the lower border of the teres major and passes in front of the tendon of that muscle. The insertion of the flat tendon into the floor of the intertubercular sulcus of the humerus will be seen later on. It is supplied by the thoracodorsal nerve.

The *trigonum lumbale* (Petit's triangle) is a triangular interval bounded in front by the posterior border of the obliquus externus abdominis, behind by the anterior border of the latissimus dorsi, and below by the crest of the ilium which forms its base. The apex is formed by the meeting of the two muscles above. The floor of the triangle is formed by the obliquus internus abdominis.

Reflect the trapezius laterally (p. 249). The accessory nerve and branches from the third and fourth cervical nerves which lie beneath the muscle are seen to enter its deep surface (p. 249). The levator scapulæ, the origin of the inferior belly of the omohyoideus, the transverse scapular artery, the suprascapular nerve, and the transverse cervical artery—all these, which the dissector of the superior extremity has to examine at this stage in conjunction with the dissector of head and neck have been described on p. 249 et seq. The rhomboidei muscles should next be cleaned and studied.

The **Rhomboideus Minor** (Fig. 54) arises (1) from the lower part of the ligamentum nuchæ, and (2) from the spinous processes of the seventh cervical and first thoracic vertebræ. It is inserted into the medial margin of the smooth triangular surface at the apex of the spine of the scapula.

The **Rhomboideus Major** (Fig. 54) arises from the spinous processes of the thoracic vertebræ, from the second to the fifth inclusive, and (2) from the corresponding supraspinous ligaments. It is inserted into a tendinous arch attached to the vertebral border of the scapula extending from the inferior angle of the scapula to the insertion of the rhomboideus minor.

The rhomboidei muscles are supplied by the dorsal scapular nerve which enters their deep surfaces.

Divide the rhomboidei muscles at their origin and reflect them lateralwards. The dorsal scapular nerve is exposed.

The dorsal scapular nerve arises from the brachial plexus (p. 293). It passes beneath the levator scapulæ (to which it gives a twig) in company with the descending branch of the transverse cervical artery and enters the deep surfaces of the rhomboidei muscles.

If the levator scapulæ has been examined by the dis-

sector of the head and neck it should be divided at its middle and the lower part reflected downwards. While reflecting the muscle one or two twigs from the dorsal scapular nerve will be seen to enter the levator scapulæ.

The *descending branch of the transverse cervical artery* (posterior scapular artery) passes under cover of the levator scapulæ (p. 251). In then descends along the vertebral border of the scapula under cover of the rhomboidei and reaches the inferior angle. It supplies the neighbouring muscles and anastomoses with the transverse scapular and subscapular arteries.

The latissimus dorsi should now be reflected. Divide the muscle by a vertical incision behind its costal origin and reflect the two portions forwards and backwards. Note the termination of the thoraco-dorsal nerve in the muscle.

The dissector of the superior extremity now stops work till the subject is put upon its back. The dissection of the back is completed by the dissector of the head and neck (see Table on p. 247).

THE PECTORAL REGION AND AXILLARY SPACE.

Devote four days to the dissection of these regions. The subject should be placed upon its back with blocks under the chest. A long wooden board is to be put under the shoulders to support the upper limbs which are to be stretched out at right angles to the chest.

Surface Anatomy.—The student should feel for himself the following bony landmarks before the skin is reflected:—the whole of the clavicle, the tip of the coracoid process (felt below the clavicle in the interval between the clavicular origins of the deltoideus and pectoralis major muscles), the acromion, the jugular notch, and the sternal angle (at the junction of the manubrium sterni and gladiolus).

Incisions (Fig. 3).—(1) A vertical incision along the median line from the centre of the jugular notch to the tip of the xiphoid process; (2) from the upper end of this incision lateralwards along the clavicle, to the tip of the acromion; (3) from the lower end of the first incision horizontally lateralwards along the side of the body; (4) from the tip of the xiphoid process upwards and lateralwards along the anterior fold of the axilla to its junction with the arm. The flaps of integument thus marked out are to be reflected but the skin of the nipple and its areola is to be left intact. This dissection requires an examination of the following structures:—

Fasciæ	1.	Superficial fascia.
	2.	Deep fascia.
	3.	Coracoclavicular fascia.
Muscles	1. 2.	Pectoralis major and minor.
	3.	Subclavius.
	4.	Serratus anterior.
Vessels	1.	Axillary artery and its branches.
	2.	Axillary vein and its tributaries.
Nerves	1.	Cutaneous.
	2.	Brachial plexus with its infraclavicular branches.
Glands		Mamma.
		Lymph glands.

The **Superficial Fascia** is fatty and in it will be seen the mamma and the cutaneous vessels and nerves. As the fascia passes upwards over the clavicle a thin layer of muscle fibres will be seen. This constitutes the lower part of the platysma.

The **Cutaneous Nerves** can be grouped into three sets:—(1) The *anterior cutaneous nerves*. These are the terminal filaments of the intercostal nerves and are found in the intercostal spaces on each side of the sternum. They become cutaneous by perforating the pectoralis

major close to the margin of the sternum, supply the skin over the sternum and give off branches, which proceed lateralwards as far as the anterior fold of the axilla. They are accompanied by the perforating branches of the internal mammary artery. (2) The *lateral cutaneous nerves*. These are also derived from the intercostal nerves and are found about midway between the vertebral column and the sternum. They become cutaneous by perforating the external intercostal and serratus anterior muscles and divide into anterior and posterior branches. The anterior branches are directed forwards to supply the skin over the pectoral region while the posterior branches are directed backwards to supply the skin over the latissimus dorsi. The first intercostal nerve does not give off a lateral cutaneous branch. The lateral cutaneous branches of the second and third intercostal nerves will be studied when the medial wall of the axillary fossa is dissected. (3) The *supraclavicular nerves* are the descending cutaneous branches of the cervical plexus. These have been described on p. 283.

In the female subject the student should dissect the mamma to display its naked-eye structure. Raise the skin over the areola towards the summit of the nipple. Remove the fat surrounding the organ and then attempt to display the lobes, the milk ducts and their ampullæ.

The **Mamma** (mammary gland) in the female extends from the side of the sternum to the anterior fold of the axilla horizontally, and from the third to the sixth or seventh rib vertically. It is separated from the pectoralis major by the deep fascia. It presents at about its centre a small conical eminence called the *mammary papilla* or *nipple*. The nipple is surrounded by a dark coloured patch of skin called the *areola*. In the skin of the areola many small eminences are seen which are due to the presence of small sebaceous glands called the *areolar*

glands (of Montgomery). The mamma is completely enclosed in a fibrous capsule from which processes, called trabeculæ, are given off into its substance dividing it into lobes. The ducts, called the *tubuli lactiferi*, fifteen to twenty in number, proceed from the lobes towards the areola. Beneath the areola they become dilated and form the *ampullæ*. At the base of the nipple they contract again and finally open upon its summit.

In the male the mamma is rudimentary.

The mamma is supplied by the intercostal arteries, the perforating branches of the internal mammary artery, and the thoracic and external mammary branches of the axillary artery.

The **Deep Fascia** (pectoral fascia) covers the pectoralis major. It is attached above to the clavicle and medially to the front of the sternum. Below it is continuous with the deep fascia covering the abdominal muscles and, at the anterior fold of the axilla, becomes continuous with the axillary fascia. Laterally it is continuous above with the deep fascia covering the deltoideus.

Remove the deep fascia to expose the pectoralis major and define also the anterior border of the deltoideus. The cephalic vein and the deltoid branch of the thoracoacromial artery are seen lying between the contiguous borders of the pectoralis major and the deltoideus.

The **Pectoralis Major** (Fig. 99) consists of a clavicular and a sternocostal portion separated from each other by a cellular interval. The *clavicular portion* arises from the anterior surface of the medial half of the clavicle, while the *costosternal portion* arises (1) from the cartilages of the upper six ribs, (2) from the anterior surface of the sternum, and (3) from the aponeurosis of the obliquus externus abdominis. The upper fibres of the muscle pass downwards and lateralwards; the lower fibres pass upwards and lateralwards; and the middle fibres pass hori-

zontally lateralwards—ultimately all the fibres end in a flat tendon which becomes inserted into the crest of the greater tubercle of the humerus. The details of its insertion will be examined during the dissection of the arm. The pectoralis major is supplied by the medial and lateral anterior thoracic nerves which enter its deep surface and will be seen when the muscle is reflected.

The student should now proceed with the dissection of the axillary space. First clean the lower border of the pectoral muscles constituting the anterior fold of the axilla. Then reflect in one piece the axillary fascia which stretches from the lower border of the pectoral muscles in front to the latissimus dorsi and teres major muscles behind which constitute the posterior fold of the axilla. Secure the lateral cutaneous branches of the second and third intercostal nerves at this stage. Remove all the fat piecemeal in the space by working cautiously from the base of the axilla towards its apex and without injuring the vessels and nerves. Clean the lower parts of the axillary vessels lying close to the lateral wall of the space. The artery lies lateral to the vein. Look for the branches of the axillary artery. The lateral thoracic artery passes medialwards along the lower border of the pectoralis minor. The subscapular artery runs medialwards along the lower border of the subscapularis in the posterior wall of the space. The anterior and posterior humeral circumflex arteries pass lateralwards; the former in front of and the latter behind the surgical neck of the humerus. The corresponding tributaries of the axillary vein are to be cleaned. A chain of lymph glands will be seen lying along the medial side of axillary artery. One or two glands of this chain should be kept. Another set of lymph glands will be seen along the course of the lateral thoracic artery. A third set will be seen along the course of the subscapular artery. Some lymph glands are found

near the centre of the base of the axilla. Next look for the branches of the brachial plexus lying most laterally against the coracobrachialis and find out the musculocutaneous nerve piercing the muscle. The medial head of the median nerve will be seen to cross the axillary artery lateralwards and join the lateral head of the nerve. The ulnar nerve lies medial to and a little behind the artery. The medial antibrachial cutaneous nerve lies between the axillary artery and the vein. The medial brachial cutaneous nerve lies medial to the axillary vein and is connected with the intercostobrachial nerve (lateral cutaneous branch of the second intercostal nerve) by a communicating filament. The radial nerve lies behind the axillary artery; and higher up behind the artery is seen the axillary nerve before that nerve winds backwards and lateralwards round the neck of the humerus. The thoracodorsal nerve crosses the subscapularis to enter the latissimus dorsi close to the medial wall. The upper and lower subscapular nerves enter the upper and lower parts respectively of the subscapularis muscle. The long thoracic nerve lies on the surface of the serratus anterior in the medial wall of the axilla. The dissector will find it difficult to clean the branches of the axillary artery and of the brachial plexus given off near the apex of the space.

The **Axilla** is the space between the side of the upper part of the chest and the upper part of the arm. It may be described as a hollow four-walled pyramid with unequal walls: thus the medial wall is longer than the lateral, while the posterior wall extends further down than the anterior.

Boundaries.—The *base* is formed by the axillary fascia. The *apex* is directed towards the root of the neck being formed by a triangular interval bounded by the superior border of the scapula behind, the clavicle in front, and

the first rib medially. The *anterior wall* is formed by the pectoralis major and minor muscles and the coracoclavi-

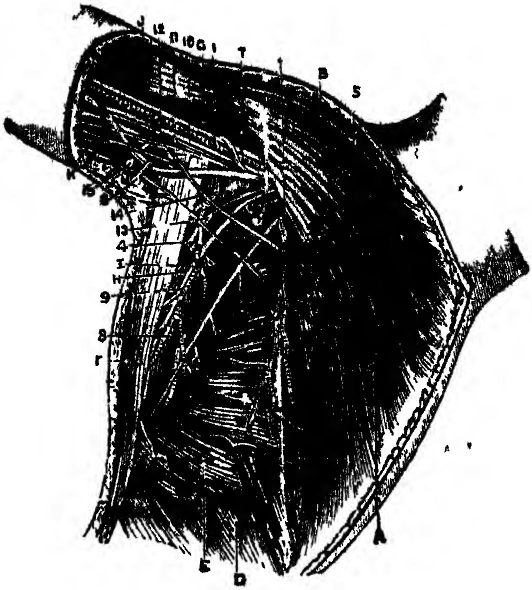


Fig. 99.—Dissection of the axilla (drawn by J. T. Gray).

A. Pectoralis major
B. Deltoideus.
D Obliquus externus abdominis.
E Serratus anterior.
F. Latissimus dorsi.
G. Coracobrachialis.
H. Teres major.
I. Subscapularis.
J. Biceps brachii
K. Triceps brachii.
1. Axillary artery.
3. Lateral thoracic artery.
4. Subscapular artery.
5. Cephalic vein.
6. Basilic vein.
7. Median nerve.
8 Long thoracic nerve.
9. Thoracodorsal nerve.
10. Ulnar nerve.
11. Medial antibrachial cutaneous nerve.
12. Medial brachial cutaneous nerve.
13. Upper subscapular nerve.
14. Intercostobrachial nerve.
15. Radial nerve.

cular fascia. The *posterior wall* [illegible] formed [illegible] the subscapularis and below by the teres major [illegible] latis-

simus dorsi. The *medial wall* is formed by the upper four ribs with the intervening intercostal muscles and the corresponding part of the serratus anterior. The *lateral wall* is formed by the upper part of the humerus together with the coracobrachialis and biceps brachii.

Contents.—The space contains the axillary artery with its branches, the axillary vein with its tributaries, the axillary lymph vessels and glands, the lower part of the brachial plexus with its infraclavicular branches, and a quantity of fat.

Divide the pectoralis major at its origin from the clavicle and reflect it downwards and lateralwards. Care should be taken of the lateral anterior thoracic nerve and of the pectoral branches of the thoracoacromial artery which enter the deep surface of the muscle at this situation. These structures should be cleaned and preserved for subsequent study. The coracoclavicular fascia is now exposed. One or two lymph glands, called the *deltoideo-pectoral lymph glands*, are found along the cephalic vein before it pierces the coracoclavicular fascia.

The **Coracoclavicular Fascia** (Costocoracoid membrane) fills up the gap between the upper border of the pectoralis minor and the clavicle. It is attached laterally to the coracoid process. Medially it is attached to the first costal cartilage and is continuous over the first and second intercostal spaces with the fascia covering them. Above it splits into two laminæ to enclose the subclavius muscle; the laminæ are then attached to the two borders of the groove for the subclavius. Below it splits at the upper border of the pectoralis minor to enclose it; at the lower border of the muscle the two layers reunite and become continuous with the axillary fascia. Behind it is continuous with the sheath of the axillary vessels. It is pierced by the cephalic vein, the thoracoacromial vessels and the lateral anterior thoracic nerve. The upper portion

of the fascia, extending from the coracoid process to the cartilage of the first rib, is thicker than the lower portion and is called the *costocoracoid ligament.*

Clean the surface of the pectoralis minor muscle. Remove the coracoclavicular fascia preserving the structures which pierce it. Note how it splits to enclose the subclavius muscle above. The thoraco-acromial artery and the lateral anterior thoracic nerve can now be traced to their origin. The cephalic vein should be traced to its termination in the axillary vein. Divide the costosternal portion of the pectoralis major and reflect it. While reflecting it note the filaments of the medial anterior thoracic nerve entering its deep surface after piercing the pectoralis minor.

The **Pectoralis Minor** arises from the outer surfaces of the third, fourth and fifth ribs near their junctions with the cartilages and from the fascia covering the intercostal muscles between those ribs. It is inserted by a narrow flattened tendon into the medial border and upper surface of the coracoid process. It is supplied by the medial anterior thoracic nerve which enters its deep surface.

Divide the pectoralis minor at about its middle and reflect the divided portions. Take care of the medial anterior thoracic nerve which enters its substance and trace it to its origin. The vessels, nerves, and lymph glands at the upper part of the axillary space close to its apex should now be thoroughly cleaned.

The **Axillary Lymph Glands** may be arranged into five groups :—(1) The *lateral group* which consists of four to six lymph glands and lies along the axillary vein. They drain lymph from the greater part of the superior extremity and their efferents open into the central and subclavicular group of lymph glands. (2) The *anterior or pectoral group* which lies along the lower border of the pectoralis

minor along the lateral thoracic artery. They drain lymph from the thoracic wall and the mamma and their efferents open into the central and subclavicular group of lymph glands. (3) The *posterior* or *subscapular group* lies along the course of the subscapular vessels and drain lymph from the back. Their efferents open into the central group of lymph glands. (4) The *central* or *intermediate group* consists of lymph glands embedded in fat near the centre of the base of the axilla. They receive lymph from all the former groups and their efferents open into the subclavicular lymph glands. (5) The *subclavicular group* consists of lymph glands situated near the apex of the axilla. They receive lymph from all other groups of axillary lymph glands and from the deltoideopectoral group. Their efferents form the subclavian lymph trunk, which joins the jugular lymph trunk in the neck or may open separately into the junction of the internal jugular and subclavian veins.

The **Axillary Artery** is the direct continuation of the subclavian artery and extends from the outer border of the first rib to the lower border of the teres major muscle. It is enclosed together with the axillary vein and the brachial plexus within a fascial sheath called the *axillary sheath*. This sheath is a prolongation downwards of the prevertebral layer of the fascia colli. In order to facilitate description it is customary to divide the axillary artery into three portions: the first portion lies above the level of the pectoralis minor; the second portion behind the muscle; and the third portion extends from the lower border of that muscle to the lower border of the teres major.

The *first portion* is placed deeply and lies under cover of the clavicular portion of the pectoralis major and the coracoclavicular fascia. It is crossed by the cephalic vein. The loop of communication between the lateral

and medial anterior thoracic nerves lies in front of it. Posteriorly it lies in relation with the first intercostal space and the first digitation of the serratus anterior. The medial cord of the brachial plexus, the long thoracic nerve, and the medial anterior thoracic nerve pass medialwards behind the vessel. To its lateral side are the lateral and posterior cords of the brachial plexus. To its medial side is the axillary vein.

The *second portion* lies under cover of the two pectoral muscles. Behind it lies the posterior cord of the brachial plexus. Lateral to it is the lateral cord; and medial to it the medial cord of the brachial plexus. The medial anterior thoracic nerve and the axillary vein also lie medially.

The *third portion* lies under cover of the pectoralis major in its upper half but is very superficial in its lower half being covered only by the skin and the superficial and deep fasciæ. It is crossed in front by the medial head of the median nerve. Posteriorly it lies in relation with the subscapularis, latissimus dorsi, and teres major in that order from above downwards. It lies over the axillary nerve above and the radial nerve below. To its lateral side are the musculocutaneous and median nerves lying between the artery and the coracobrachialis. To its medial side are the medial antibrachial cutaneous and ulnar nerves separating it from the axillary vein.

Branches.—The branches of the axillary artery are: from the first portion (1) the highest thoracic; from the second portion (2) the thoracoacromial and (3) lateral thoracic; from the third portion (4) the subscapular, (5) anterior humeral circumflex, and (6) posterior humeral cricumflex.

The Highest Thoracic Artery (Superior thoracic) is a small branch which passes medialwards, supplies the

upper part of the thoracic wall and anastomoses with the intercostal and internal mammary arteries.

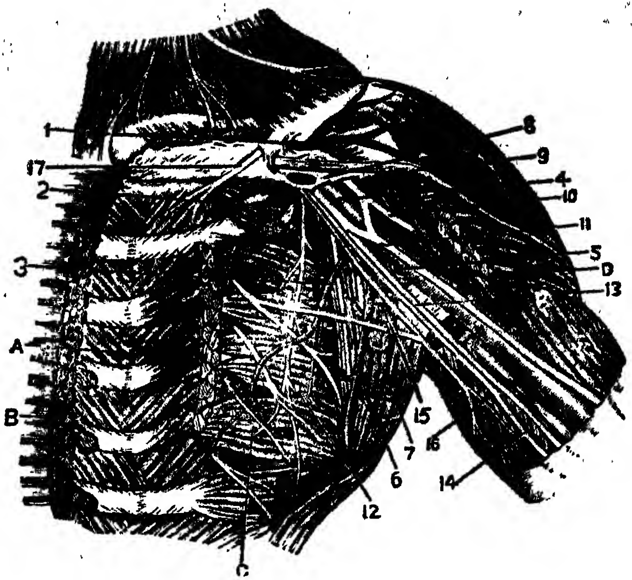


Fig. 100.—The axillary artery and its branch es (drawn by G. E. L. Pearse).

A. **Pectoralis minor (cut).**
B. **Pectoralis major (cut).**
C. **Serratus anterior.**
D. **Pectoralis major.**
1. **Thoracoacromial artery.**
2. **Highest thoracic artery.**
3. **Lateral thoracic artery.**
4. **Axillary artery.**
5. **Posterior humeral circumflex artery.**
6. **Subscapular artery.**
7. **Scapular circumflex artery.**
8. **Coracoclavicular fascia.**
9. **Cephalic vein.**
10. **Musculocutaneous nerve.**
11. **Median nerve.**
12. **L o ng thoracic nerve.**
13. **Ulnar nerve.**
14. **Medial antibrachial cutaneous nerve.**
15. **Axillary nerve.**
16. **Medial brachial cutaneous nerve joined by intercostobrachial nerve.**
17. **Lateral anterior thoracic nerve.**

The **Thoracoacromial Artery** (Thoracic axis) is a short trunk which arises from the front aspect of the axillary

artery. It pierces the coracoclavicular fascia and divides into four branches :—(1) The *pectoral branch* (thoracic branch) which descends between the pectoral muscles, supplies them and anastomoses with the lateral thoracic and intercostal arteries. (2) The *clavicular branch* which passes upwards and medialwards on the coracoclavicular fascia and supplies the subclavius muscle and the sternoclavicular joint. (3) The *acromial branch* passes lateralwards beneath the deltoideus and supplies it ; it then pierces that muscle and ramifies over the acromion where it anastomoses with the branches of the transverse scapular and posterior humeral circumflex arteries. (4) The *deltoid branch* (humeral branch) passes downwards along the interval between the clavicular portion of the pectoralis major and the deltoideus and supplies both the muscles.

The **Lateral Thoracic Artery** (long thoracic) runs medialwards along the lower border of the pectoralis minor to the thoracic wall and supplies the pectoral muscles and the serratus anterior and anastomoses with the intercostal and subscapular arteries. In the female it gives off a branch, called the *external mammary artery*, which goes to supply the mamma.

The **Subscapular Artery** is the largest branch of the axillary artery. It passes downwards and medialwards along the lower border of the subscapularis to the inferior angle of the scapula where it anastomoses with the lateral thoracic and intercostal arteries. It supplies the neighbouring muscles. About an inch after its origin it gives off a large branch, called the *scapular circumflex artery* (dorsalis scapulæ), which curves round the axillary border of the scapula and reaches the infraspinous fossa, where it will be subsequently examined.

The **Anterior Humeral Circumflex Artery** (anterior circumflex) arises below the preceding artery and passes

lateralwards beneath the coracobrachialis and short head of the biceps brachii in front of the surgical neck of the humerus and, reaching the intertubercular sulcus, divides into two branches. One of these ascends along the intertubercular sulcus to supply the shoulder joint while the other passes lateralwards beneath the deltoideus and anastomoses with the posterior humeral circumflex artery.

The **Posterior Humeral Circumflex Artery** (posterior circumflex) arises behind the preceding artery or sometimes in common with it. It passes backwards with the axillary nerve through the quadrilateral space, bounded above by the teres minor, below by the teres major, medially by the long head of the triceps, and laterally by the humerus. Its further course and termination will be seen later on.

The **Axillary Vein** is the continuation upwards of the basilic vein of the arm. At the lower border of the subscapularis it is joined by the two venæ comites of the brachial artery. It lies on the medial side of its companion artery. It receives tributaries corresponding to the branches of the axillary artery and in the upper part of the axilla the cephalic vein opens into it. At the outer border of the first rib it becomes the subclavian vein.

The **Subclavius** arises by a tendon from the junction of the first rib with its cartilage. It passes upwards and lateralwards to be inserted into the groove on the undersurface of the clavicle. It is supplied by a special branch from the brachial plexus given off above the clavicle; this branch is derived from the point of junction of the fifth and sixth cervical nerves.

Brachial Plexus (Fig. 63).—The student should now proceed to dissect the brachial plexus of nerves. For this purpose the middle third of the clavicle is to be removed with a saw. The subclavius muscle is then to

be reflected together with its nerve. It is necessary that the dissector of the superior extremity should work in conjunction with the dissector of the head and neck so that the structures passing from the neck to the axilla may be studied in their continuity. The formation of the brachial plexus and its branches given off above the clavicle have been fully described on page 290 et seq. The branches given off below the clavicle belong to the dissector of the superior extremity. These are derived from the three cords of the brachial plexus. Three branches are given off from the lateral cord, viz., the lateral anterior thoracic nerve, the musculocutaneous nerve, and the lateral head of the median nerve. Five branches are given off from the medial cord, viz., the medial anterior thoracic nerve, the medial brachial cutaneous nerve, the medial antibrachial cutaneous nerve, the ulnar nerve, and the medial head of the median nerve. The posterior cord also gives off five branches, viz., the upper and lower subscapular nerves, the thoracodorsal nerve, the axillary nerve, and the radial nerve.

The **Lateral Anterior Thoracic Nerve** (external anterior thoracic nerve) arises from the lateral cord of the plexus, passes forwards and, crossing the axillary artery and vein, pierces the coracoclavicular fascia. It then enters the deep surface of the pectoralis major to supply it. A filament from it usually joins the medial anterior thoracic nerve forming a loop which lies in front of the axillary artery.

The **Medial Anterior Thoracic Nerve** (internal anterior thoracic nerve) arises from the medial cord. Passing behind the first portion of the axillary artery it proceeds forwards between that artery and its companion vein and is joined by a filament from the lateral anterior thoracic nerve. It then passes to the undersurface of the pectoralis minor to be distributed to that muscle; some filaments

pierce the muscle and enter the deep surface of the pectoralis major.

Subscapular Nerves.—The *upper subscapular nerve*, the smaller of the two subscapular nerves, enters the upper part of the subscapularis. The *lower subscapular nerve* supplies the lower part of the subscapularis and the teres major.

The **Thoracodorsal Nerve** (middle or long subscapular nerve) passes downwards in company with the subscapular artery along the posterior wall of the axilla to supply the latissimus dorsi.

The remaining branches of the brachial plexus will be studied during the dissection of the arm and the parts about the scapula.

The **Intercostobrachial nerve** (intercostohumeral nerve) is the lateral cutaneous branch of the second intercostal nerve. It lies on the medial wall of the axilla and can be well examined now. Like the other lateral cutaneous branches it does not divide into an anterior and a posterior branch. The undivided nerve passes along the base of the axilla to the medial side of the upper part of the arm and supplies the skin over its medial and back parts. In the axilla it communicates by a filament with the medial brachial cutaneous nerve.

Note that no lateral cutaneous branch is given off from the first intercostal nerve. The posterior offset of the lateral cutaneous branch of the third intercostal nerve is sometimes large and reaches the skin on the medial aspect of the upper part of the arm like the intercostobrachial nerve.

The **Serratus Anterior** (Serratus magnus) arises by fleshy digitations from the outer surfaces of the upper eight ribs. The first digitation is large and arises from two ribs, the first and the second. The remaining digitations arise from the corresponding ribs. The lower

three slips interdigitate with the obliquus externus abdominis. The muscle is inserted into the ventral aspect of the whole length of the vertebral border of the scapula. The first digitation converges to be inserted into the ventral aspect of the medial angle of the scapula. The lower five digitations converge to be inserted into the ventral aspect of the inferior angle of the scapula. The remaining digitations diverge to be inserted into the intermediate portion of the ventral aspect of the vertebral border of the scapula. The serratus anterior is supplied by the long thoracic nerve which lies on the surface of the muscle.

The limb should now be removed from the trunk by dividing the serratus anterior and the inferior belly of the omohyoideus: the axillary vessels and the cords of the brachial plexus are to be tied together and then divided above the ligature. The transverse scapular vessels and the suprascapular nerve are to be divided at the suprascapular notch. Some other small vessels and nerves require to be divided to complete the separation.

UPPER PART OF THE ARM AND SCAPULAR REGION.

Place the upper limb on a table and remove the skin from the front and lateral aspects of the upper third of th arm.

The **Cutaneous Nerves** are: (1) The *posterior supra-clavicular nerves.* These have been described (p. 283). They supply the skin of the front and lateral parts of the shoulder. (2) The *lateral brachial cutaneous nerve* (Fig. 101) is a branch of the posterior division of the axillary nerve. It becomes cutaneous at the posterior border of the deltoideus and passing medialwards supplies the skin over the lower two-thirds of the muscle. (3) Some

filaments from the anterior division of the axillary nerve pierce the deltoideus and supply the skin over it.

The **Deep Fascia** presents differences in character in the different parts of the shoulder and scapular region. Where it covers the supraspinatus muscle it is called the *fascia supraspinata* and is thicker medially than laterally. It is attached to the margins of the supraspinous fossa. The *fascia infraspinata* covers the infraspinatus muscle. It is attached to the margins of the infraspinous fossa and is continuous in front with the fascia covering the deltoideus. The *subscapular fascia* covers the subscapularis; it is thin but strong and is attached to the circumference of the subscapular fossa. The fascia covering the deltoideus is thin in front where it is continuous with the pectoral fascia and thick behind where it is continuous with the fascia infraspinata. Below it is continuous with the brachial fascia and above it is attached to the clavicle and acromion.

The **Deltoideus** is a triangular muscle which arises (1) from the anterior border of the lateral third of the clavicle, (2) from the lateral margin of the acromion, and (3) from the lower lip of the posterior border of the spine of the scapula. The fibres of the muscle converge and finally end in a tendon which is inserted into the deltoid tuberosity on the lateral surface of the humerus. It is supplied by the axillary nerve.

Divide the deltoideus near its origin and reflect it downwards. Notice that a large bursa is placed between the deltoideus and the shoulder-joint. Trace the posterior humeral circumflex artery and the axillary nerve. Trace the nerve to the teres minor given off from the axillary nerve. Lastly cut the trapezius close to the spine of the scapula.

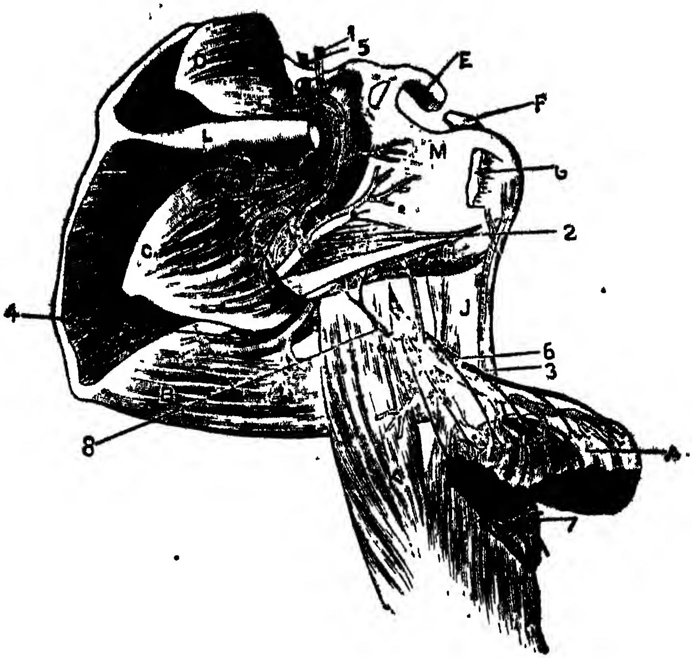
Posterior Humeral Circumflex Artery.—Its origin from the third portion of the axillary artery has been

already seen. It gains the back part of the shoulder through the *quadrilateral space* bounded above by the subscapularis and teres minor, below by the teres major, medially by the long head of the triceps, and laterally by the surgical neck of the humerus. It is accompanied by the axillary nerve and divides into several branches which enter the deep surface of the deltoideus. It anastomoses above with the acromial branch of the thoracoacromial artery, in front with the anterior humeral circumflex and below with the profunda branch of the brachial artery.

The **Axillary Nerve** (Circumflex nerve), (Fig. 101).—Its origin from the posterior cord of the brachial plexus has been seen. At the lower border of the subscapularis it turns backwards through the quadrilateral space in company with the posterior humeral circumflex artery and supplies a twig to the shoulder-joint. It divides into two branches, an anterior and a posterior. The *anterior branch* passes round the humerus under cover of the deltoideus to reach its anterior border and breaks up into several filaments; some filaments enter the deep surface of the muscle to supply it, while others pierce the muscle and ramify in the skin covering its lower part. The *posterior branch* gives off a twig to the teres minor which presents an elongated swelling (pseudoganglion) on it. After supplying a few twigs to the back part of the deltoideus the posterior branch pierces the deep fascia and is continued as the *lateral brachial cutaneous nerve*, the distribution of which has been already seen.

The **Supraspinatus** (Fig. 101) fills up the supraspinous fossa and arises from its medial two-thirds and from the deep surface of the fascia supraspinata. The muscle passes lateralwards beneath the acromion and is inserted by its tendon into the uppermost impression on the greater tubercle of the humerus. The tendon is firmly

Fig. 101.—Dissection of the posterior scapular region. The triangular and quadrilatera spaces are seen from behind (Cunningham).



A. Deltoideus.
B. Teres major.
C. Infraspinatus.
D. Supraspinatus.
E. Coracoid process.
F. Tendon of supraspinatus.
G. Tendon of infraspinatus.
H. Teres minor.
J. Body of humerus.
K. Long head of triceps brachii.
L. Spine of scapula.
M. Capsule of shoulder joint.
1. Transverse scapular artery.
2. Scapular circumflex artery.
3. Posterior humeral circumflex artery.
4. Descending branch of scapular circumflex artery.
5. Suprascapular nerve.
6. Axillary nerve.
7. Lateral brachial cutaneous branch of axillary nerve.
8. Nerve to teres minor.

adherent to the capsule of the shoulder-joint. It is supplied by the suprascapular nerve.

The **Infraspinatus** (Fig. 101) arises from the medial two-thirds of the infraspinous fossa and from the deep surface of the fascia infraspinata. It is inserted into the middle impression on the greater tubercle of the humerus. Like the preceding muscle its tendon of insertion is closely blended with the capsule of the shoulder joint. It is supplied by the suprascapular nerve which will be seen when the muscle is reflected.

The **Teres Minor** (Fig. 101) arises from the dorsal aspect of the upper two-thirds of the axillary border of the scapula and from the intermuscular septa separating it from the infraspinatus and teres major muscles. It is inserted by a tendon into the lowermost impression on the greater tubercle of the humerus and by fleshy fibres into the surface of bone immediately below that impression to the extent of about half an inch. It is supplied by a twig from the axillary nerve.

The **Teres Major** (Fig. 101) arises from the oval area on the dorsal aspect of the scapula close to its inferior angle; and from the intermuscular septa separating it from the teres minor and infraspinatus muscles. It ends in a flattened tendon which is inserted into the crest of the lesser tubercle of the humerus. It is supplied by the lower subscapular nerve.

The **Subscapularis** arises from the medial two-thirds of the subscapular fossa and from the groove on the ventral aspect of the axillary border of the scapula. The muscle passes lateralwards in front of the capsule of the shoulder joint and is inserted by a tendon into the lesser tubercle of the humerus. The tendon of insertion is blended with the capsule of the shoulder-joint. It is supplied by the upper and lower subscapular nerves.

The dissector should now examine the precise manner

of insertion of each of the tendons of the following muscles, viz., the latissimus dorsi, the teres major and the pectoralis major. The quadrilateral tendon of the latissimus dorsi is inserted into the bottom of the intertubercular sulcus in front of the insertion of the tendon of the teres major. The tendons of these two muscles are united with each other at their lower borders but a mucous bursa intervenes between them. The flat tendon of the pectoralis major is inserted into the crest of the greater tubercle of the humerus and consists of two laminæ, an anterior and a posterior. The posterior lamina is attached to the crest higher on the bone than the anterior lamina, and a fibrous expansion is given off from its upper part which is blended with the capsule of the shoulder-joint. It should also be noted that the anterior lamina which is placed in front of the posterior receives the upper fibres of the pectoralis major, whereas the posterior lamina receives its lower fibres which are folded behind the upper fibres. The two laminæ are blended together below.

The supraspinatus is now to be divided about two inches from its insertion and the muscle is to be pulled backwards without injuring the vessels and nerves which supply it. The infraspinatus is to be dealt with in a similar manner. Sometimes a bursa is seen between the tendon of the infraspinatus and the capsule of the shoulder-joint. The distribution of the transverse scapular artery and the suprascapular nerve will now be seen. The subscapularis is to be detached at its origin from the scapula and reflected towards its insertion. The vessels in the subscapular fossa are exposed. A bursa will be seen lying between the muscle and the front part of the capsule of the shoulder joint. This bursa communicates with the synovial stratum inside the capsule.

The Transverse Scapular Artery (Fig. 101) has been

traced from its origin to the upper border of the scapula. It passes over the superior transverse ligament of the scapula to gain the supraspinous fossa beneath the supraspinatus. Here it gives off branches to the supraspinatus and a nutrient artery to the scapula. It then reaches the infraspinous fossa by passing through the great scapular notch beneath the inferior transverse ligament of the scapula. Here it supplies branches to the infraspinatus and anastomoses with the scapular circumflex artery near the axillary border and with the descending branch of the transverse cervical artery near the vertebral border of the scapula. When it crosses the superior transverse ligament it gives off a *subscapular branch* which enters the subscapular fossa beneath the subscapularis, supplies the muscle and anastomoses with the subscapular artery and with the descending branch of the transverse cervical artery.

The **Suprascapular Nerve** (Fig. 101) enters the supraspinous fossa through the scapular notch beneath the superior transverse ligament of the scapula. Here it supplies the supraspinatus and gives articular twigs to the shoulder-joint. It then passes through the great scapular notch, reaches the infraspinous fossa and supplies the infraspinatus. It also gives articular twigs to the shoulder-joint.

The **Scapular Circumflex Artery** (Fig. 101) has been seen to reach the dorsal aspect of the scapula across its axillary border through the *triangular space* bounded by the subscapularis, the teres major, and the long head of the triceps. It then enters the infraspinous fossa under cover of the teres minor and anastomoses with the transverse scapular and descending branch of transverse cervical arteries. At the axillary border it gives off an *infrascapular branch* which enters the subscapular fossa beneath the subscapularis and anastomoses with the

subscapular branch of the transverse scapular artery and the descending branch of the transverse cervical artery. On the dorsal aspect of the axillary border it gives off another branch which descends between the teres minor and major muscles to the inferior angle of the scapula and anastomoses with the descending branch of the transverse cervical artery.

The dissector should note that very important arterial anastomoses take place on the dorsal and ventral aspects of the scapula—between the branches of the subscapular artery, which arises from the axillary artery, and the transverse scapular and the descending branch of the transverse cervical artery, which are derived from the thyreocervical trunk of the subclavian artery.

Ligaments of the Scapula (Fig. 107).—These are (1) The coracoacromial ligament, (2) the superior transverse ligament, and (3) the inferior transverse ligament. The *coracoacromial ligament* is a triangular band which is attached by its narrow end to the apex of the acromion and by its broad base to the lateral border of the coracoid process. This ligament together with the acromion and coracoid process forms an arch for the protection of the upper part of the shoulder-joint. Beneath the acromion is a bursa called the *subacromial bursa* which is continuous with the bursa under cover of the deltoideus. The *superior transverse ligament* (suprascapular ligament) bridges over the scapular notch. The transverse scapular artery crosses over it, while the suprascapular nerve passes beneath the ligament. It may be partly or wholly ossified. The *inferior transverse ligament* (spinoglenoid ligament) extends from the lateral border of the spine of the scapula to the adjacent margin of the glenoid cavity. The transverse scapular artery and the suprascapular nerve pass beneath it to the infraspinous fossa.

The Acromioclavicular Articulation is a diarthrodial joint between the acromial end of the clavicle and the medial border of the acromion. The ligaments are:—(1) The *articular capsule* which surrounds the articular surfaces. It is lined by a synovial stratum which may be partially or completely subdivided into two by the articular disc inside the joint. (2) The *acromioclavicular ligament* which strengthens the articular capsule superiorly and extends between the adjoining rough surfaces of the two bones. (3) The *articular disc* is sometimes found inside the joint between the articular surfaces. When present it usually extends for some distance from above downwards. Rarely it completely subdivides the joint cavity into two. Besides these there is an accessory ligament which strengthens the articulation. It is called the *coracoclavicular ligament* (Fig. 107) and consists of two bands, called the trapezoid and conoid ligaments. The *trapezoid ligament* is attached above to the oblique ridge on the undersurface of the lateral third of the clavicle and below to the oblique ridge on the upper aspect of the coracoid process. The *conoid ligament* lies posteromedially to the trapezoid ligament. It is conical in shape and is attached by its apex to the base of the coracoid process medial to the attachment of the trapezoid ligament. Its base is attached to the conoid tuberosity on the undersurface of the lateral third of the clavicle. It is usually separated from the trapezoid ligament by a mucous bursa.

THE FRONT OF THE ARM.

The student should now proceed with the superficial dissection of the front of the arm concurrently with that of the front of the forearm so that the cutaneous nerves and veins can be examined in their entirety.

Surface Anatomy.—The lesser tubercle at the superior extremity of the humerus can be felt as it projects forwards below the acromioclavicular joint. The bony landmarks near the elbow-joint should be recognised. The medial and lateral supracondylar ridges can be felt; the lateral one is more prominent. The medial epicondyle is more conspicuous than the lateral. The latter is however seen plainly as an eminence during semiflexion of the forearm. The olecranon can always be felt at the back part of the elbow-joint between the two epicondyles. The triangular subcutaneous surface at the back part of the olecranon will be felt in continuity with the dorsal border of the body of the ulna which is subcutaneous throughout its whole length. When the forearm is extended there is a slight dimple immediately below the lateral epicondyle of the humerus. This corresponds with the head of the radius. The lower fourth of the medial surface of the body of the ulna and the styloid processes of the radius and ulna should be felt. The biceps brachii muscle forms a long prominence in front of the arm and its tendon can be easily felt at the bend of the elbow. In a fairly muscular subject three muscular elevations can be recognised on the front aspect of the elbow. The one in the middle corresponds to the tendon of the biceps brachii, that on the lateral side corresponds to the brachioradialis and the common mass of extensor muscles of the forearm attached to the lateral epicondyle of the humerus; and that on the medial side corresponds to the position of the pronator teres and the common mass of flexor muscles of the forearm attached to the medial epicondyle of the humerus.

Reflect the skin by the following incisions:—(1) A longitudinal incision along the middle line of the front of the arm and forearm; (2) a transverse incision just above the wrist-joint.

The following structures require to be studied in this dissection :—

Fasciæ	1. Superficial. 2. Deep.
Muscles	1. Biceps brachii. 2. Coracobrachialis. 3. Brachialis.
Vessels	1. Superficial veins. 2. Brachial artery and its branches.
Nerves	1. Cutaneous. 2. Musculocutaneous. 3. Median. 4. Ulnar. 5. Radial.

The **Cutaneous Nerves** are :—(1) The intercostobrachial nerve, (2) the posterior brachial cutaneous branch of the radial nerve, (3) the medial brachial cutaneous nerve, (4) the medial antibrachial cutaneous nerve, (5) the dorsal antibrachial cutaneous branch of the radial nerve, and (6) the lateral antibrachial cutaneous nerve.

The *intercostobrachial nerve* is the lateral cutaneous branch of the second intercostal nerve. It has been traced from its origin to the medial side of the arm (p. 587). It supplies the skin of the medial and posterior aspects of the upper half of the arm.

The *posterior brachial cutaneous branch of the radial nerve* (internal cutaneous branch of the musculospiral nerve) arises in the axilla, passes to the back part of the arm and supplies the skin on its dorsal aspect. It can be traced as far as the olecranon. It communicates with the intercostobrachial nerve.

The *medial brachial cutaneous nerve* (Nerve of Wrisberg, lesser internal cutaneous nerve) pierces the deep fascia on the medial aspect of the arm at about its middle and supplies the skin on the medial and back part of the lower third of the arm.

The *medial antibrachial cutaneous nerve* (internal cutaneous nerve) also pierces the deep fascia on the medial

aspect of the arm at about its middle and passes downwards close to the basilic vein. Opposite the bend of the elbow it usually runs beneath the median basilic or median cubital vein and divides into two branches, volar and ulnar. The *volar branch* descends along the volar aspect of the medial side of the forearm supplying the skin as low down as the wrist. The *ulnar branch* supplies the skin over the medial aspect of the forearm in its upper two-thirds.

The *dorsal antibrachial cutaneous nerve* (external cutaneous branch of the musculospiral nerve) arises from the radial nerve. Piercing the lateral head of the triceps brachii it divides into two branches, an upper and a lower. Both become cutaneous by piercing the deep fascia at the lateral side of the arm at about its middle. The *upper branch* is the smaller; it suplies the skin of the lower third of the arm on its lateral aspect. The *lower branch* descends along the lateral side of the arm and the dorsal aspect of the forearm to the wrist.

The *lateral antibrachial cutaneous nerve* is the cutaneous part of the musculocutaneous nerve. It pierces the deep fascia in front of the elbow, passes downwards behind the cephalic vein and divides into a volar and a dorsal branch. The *volar branch* descends along the radial side of the front of the forearm to the wrist. Its terminal twig will be traced to the ball of the thumb during the dissection of the palm. Near the wrist it communicates with the superficial branch of the radial nerve. The *dorsal branch* descends along the radial side of the dorsal aspect of the forearm and can be traced as far as the wrist.

Superficial Veins.—The superficial veins of the forearm are three in number; the cephalic, the basilic, and the median antibrachial vein.

Cephalic vein.—Its origin from the lateral end of the

dorsal venous network of the palm will be seen later on. It ascends along the dorsal aspect of the radial side of

Fig. 102.—Cutaneous dissection of the front of the arm (from Hirschfeld and Leveille).

1. Cephalic vein.
2. Basilic vein.
3. Cephalic vein.
4. Basilic vein.
5. Median antibrachial vein dividing into 6, 7, median basilic and median cephalic veins.
8. Posterior supraclavicular branches.
9. Medial brachial cutaneous nerve.
10. Intercostobrachial nerve.
11. Medial antibrachial cutaneous nerve.
12. Posterior brachial cutaneous branch of radial nerve.
13. Musculocutaneous nerve.
14. Dorsal antibrachial cutaneous branch of the radial nerve.
15. Axillary nerve.

the forearm and gradually reaches its front aspect by winding round its radial margin. It then ascends along the front aspect of the radial side of the forearm.

receiving tributaries in its course and at the bend of the elbow communicates with the basilic vein by a venous channel called the *median cubital vein.* One of the tributaries is larger than the others and is called the *accessory cephalic vein.* It runs along the dorsal aspect of the radial border of the forearm and joins the cephalic vein a little below the bend of the elbow. From the elbow the cephalic vein passes upwards along the groove between the triceps brachii and the brachialis and at the upper part of the arm passes between the deltoideus and the pectoralis major. It then pierces the coracoclavicular fascia and terminates in the axillary vein.

Basilic vein.—Its origin at the medial end of the dorsal venous network of the hand will be seen later on. From its origin it passes upwards at first along the dorsal aspect of the ulnar side of the forearm. Below the elbow it passes to the front aspect of the ulnar side of the forearm and receives tributaries from its dorsal aspect. At the bend of the elbow it is joined by the medial cubital vein. It then ascends along the groove between the biceps brachii and the brachialis on the medial side of the arm and pierces the deep fascia at about the middle of the arm. Finally it runs along the medial side of the brachial artery and, reaching the lower border of the teres major, becomes the axillary vein.

The *median cubital vein* (median basilic vein) arises from the cephalic vein at the bend of the elbow and passes upwards and medialwards to join the basilic vein. The vein lies on a thickened band of fascia derived from the tendon of the biceps brachii, called the lacertus fibrosus, which separates it from the brachial artery.

The *median antibrachial vein* begins in a venous plexus on the volar aspect of the palm and ascends along the middle line of the front of the forearm to join the median cubital vein or the basilic vein at the bend of the elbow.

Sometimes the median cubital vein is absent. Under such circumstances the median antibrachial vein usually

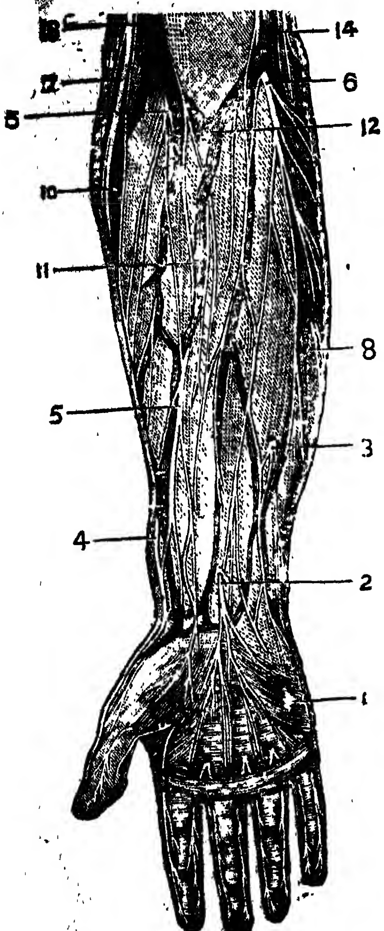


Fig. 108.—Cutaneous dissection of the front of the forearm and hand (from Hirschfeld and Leveille).

1. Palmaris brevis.
2. Palmar cutaneous branch of median nerve.
3. Palmar cutaneous branch of ulnar nerve.
4. Lateral branch of superficial branch of radial nerve.
5. Musculocutaneous nerve.
6. Medial antibrachial cutaneous nerve.
7 Dorsal antibrachial cutaneous branch of radial nerve.
8. Basilic vein.
10. Cephalic vein.
11. Median antibrachial vein.
12. A communicating vein joining the bifurcation of the median antibrachial vein.
13. Cephalic vein.
14. Basilic vein.

bifurcates at the bend of the elbow into two branches, median basilic and median cephalic. The *median basilic vein* passes upwards and medialwards to join the basilic

vein and the *median cephalic vein* passes upwards and lateralwards to join the cephalic vein. Figure 102 shows this arrangement. Before its bifurcation it communicates with the brachial veins.

Superficial lymph glands.—One or two small lypmph glands, called the *supratrochlear lymph glands,* will be seen just above the medial epicondyle of the humerus along the side of the basilic vein. They receive superficial lymphatic vessels from the ulnar side of the hand and forearm.

The deep fascia of the arm or the **brachial fascia** forms a covering for the muscles of the arm. Above it is continuous with the fascia covering the deltoideus and the pectoralis major and receives expansions from their tendons. Above and medially it is continuous with the axillary fascia. Below it is continuous with the deep fascia of the forearm and is attached to the epicondyles of the humerus and the olecranon. In front of the elbow-joint it is strengthened medially by the lacertus fibrosus. Partitions or septa are given off from the deep surface of the brachial fascia. These are known as the medial and lateral intermuscular septa. To see their connections divide the deep fascia vertically along the middle line of the forearm and reflect them on either side. The *medial intermuscular septum* is attached to the medial supracondylar ridge and extends above as far as the insertion of the coracobrachialis. The *lateral intermuscular septum,* weaker than the preceding, is attached to the lateral supracondylar ridge and extends above as far as the insertion of the deltoideus. These septa and the bone divide the arm into two compartments, an anterior and a posterior (Fig. 104). As the dissection proceeds the student will notice the structures contained in each of these compartments.

The muscles in front of the arm are now to be studied.

The **Biceps Brachii** has two heads of origin, viz., a long head and a short head. The origin of the *long head* from the supraglenoid tuberosity of the scapula and from the adjacent glenoidal labrum will be seen during the dissection of the shoulder-joint. Its tendon passes through the capsule of the shoulder joint and issues out of it beneath the transverse humeral ligament. It then descends along the intertubercular sulcus being retained at this situation by a prolongation from the tendon of the pectoralis major. It ends in a fleshy belly which unites with that of the short head. The *short head* arises from the tip of the coracoid process of the scapula by a tendon in common with the origin of the coracobrachialis. It ends in a fleshy belly which unites with that of the long head at about the middle of the arm to form one muscle, which ends in a strong tendon. This tendon is inserted into the posterior part of the tuberosity of the radius. A bursa is interposed between the tendon and the anterior part of the tuberosity. Opposite the bend of the elbow the tendon gives off from its medial margin a strong broad aponeurosis, called the *lacertus fibrosus* (bicipital fascia), which passes downwards and medialwards and blends with the deep fascia covering the pronator teres muscle.

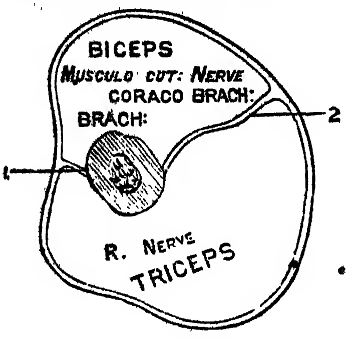


Fig. 104.—Diagram of the transverse section of the upper arm showing the intermuscular septa and the anterior and posterior compartments (after Turner). 1. Lateral intermuscular septum. 2. Medial intermuscular septum.

The median cubital or median basilic vein lies over this fascia. The biceps brachii is supplied by the musculo-cutaneous nerve.

The **Coracobrachialis** arises from the tip of the coracoid process in common with the short head of the biceps brachii. It is inserted into the medial surface and border of the body of the humerus at about its middle. It is supplied by the musculocutaneous nerve which usually gives off a branch to it before piercing the muscle.

The **Brachialis** (Brachialis anticus) arises (1) from the lower half of the anteromedial and anterolateral surfaces of the body of the humerus, (2) from the medial inter-muscular septum, and (3) from the upper part of the lateral intermuscular septum. The origin from the body of the humerus embraces the insertion of the del-toideus. The muscle terminates in front of the elbow in a thick tendon which is inserted into an impression on the anteroinferior surface of the coronoid process of the ulna. It is supplied chiefly by the musculocutaneous nerve and receives also one or two filaments from the radial nerve.

The dissector should now examine the course and relations of the brachial artery with its branches, and the nerves of the arm.

The **Brachial Artery** is the continuation of the axillary artery and extends from the lower border of the teres major muscle to about half an inch below the bend of the elbow where it divides into the radial and ulnar arteries. At the upper part of the arm it lies to the medial side of the humerus, but lower down it gradually inclines lateral wards and reaches the front aspect of the bone. At the bend of the elbow it is placed midway between the two epicondyles. It is accompanied by two venæ comitantes which communicate with each other at short intervals by cross branches.

Relations.—The artery is superficial throughout its whole extent being covered by the skin and the superficial and deep fasciæ. The lacertus fibrosus lies between it and the median cubital or median basilic vein at the bend of the elbow. It is crossed by the median nerve at about its middle from the lateral to the medial side. Laterally it is overlapped by the coracobrachialis and the biceps brachii and the median nerve at the upper part. On its medial side are the medial antibrachial cutaneous and ulnar nerves at the upper part and the median nerve at the lower part. The basilic vein lies medial to the artery throughout the whole length of the arm. Posteriorly it is in relation from above downwards with the long head of the triceps brachii (the radial nerve and the arteria profunda brachii intervening), the medial head of the same muscle, the coracobrachialis, and the brachialis.

Branches.—(1) *Arteria profunda brachii* (superior profunda artery) arises from the medial and back part of the parent trunk a little below the tendon of the teres major and passes backwards between the lateral and medial heads of the triceps brachii accompanied by the radial nerve. It will be traced again during the dissection of the arm. Its *terminal branch* appears laterally in front of the arm by piercing the lateral intermuscular septum with the radial nerve. It then descends along the interval between the brachialis medially, and the brachioradialis and extensor digitorum longus laterally to the front of the lateral epicondyle where it anastomoses with the radial recurrent branch of the radial artery.

(2) The *superior ulnar collateral artery* (inferior profunda artery) arises near the middle of the arm, passes downwards and medialwards and pierces the medial intermuscular septum with the ulnar nerve. It then descends behind the septum accompanied by the ulnar nerve to the interval between the olecranon and the medial

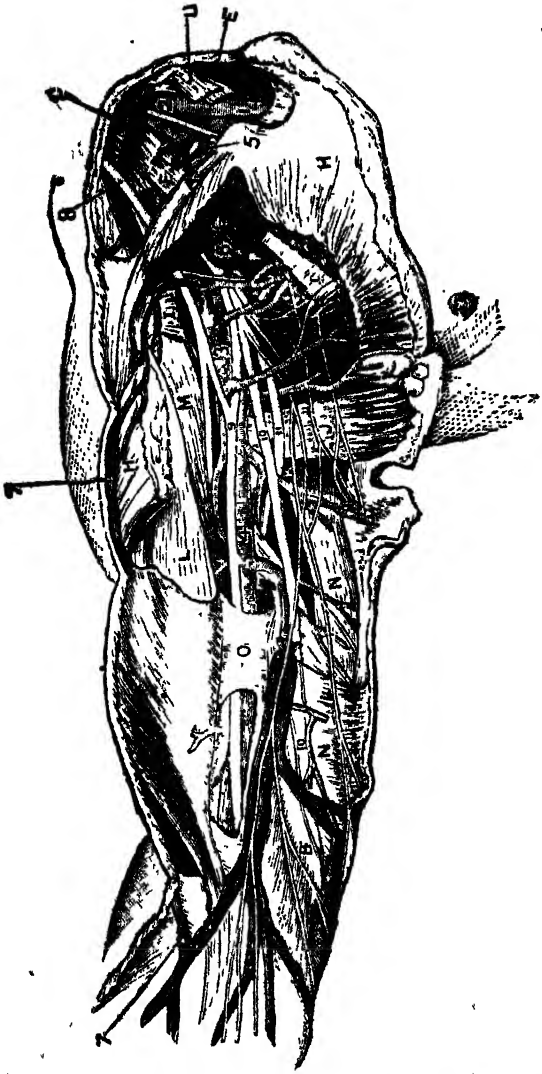


Fig. 105.—Dissection of the upper arm (from Maclise's Surgical Anatomy).

A. Clavicle.
B. Medial epicondyle.
C. Sterno-cleido-mastoideus.
D. Sternohyoideus.
E. Sternothyreoideus.
F. Scalenus anterior.
G. Subclavius.
H. Pectoralis major.
I. Pectoralis minor.
J. Lattissimus dorsi.
K. Teres major.
L. Biceps brachii.
M. Coracobrachialis.
N. Triceps brachii.
O. Deep fascia of arm.

1. Innominate artery.
2. Common carotid artery.
3. Axillary artery.
4. Brachial artery.
5. Junction of internal jugular and subclavian veins.
6. Axillary vein.
7. Cephalic vein.
8. Upper trunk of brachial plexus.
9. Median nerve.
10. Ulnar nerve.
11. Radial nerve.

epicondyle of the humerus. Here it anastomoses with the posterior ulnar recurrent and inferior ulnar collateral arteries.

(3) The *inferior ulnar collateral artery* (anastomotica magna) arises about two inches above the elbow-joint passes medialwards upon the brachialis and divides into two branches, an anterior and a posterior. The *anterior branch* descends in front of the medial epicondyle of the humerus to anastomose with the anterior ulnar recurrent artery. The *posterior branch* proceeds to the posterior aspect of the arm by piercing the medial intermuscular septum and will be traced again during the dissection of the back of the arm.

(4) The *nutrient artery* of the humerus usually arises about the middle of the arm. It enters the nutrient foramen of the bone near the insertion of the coracobrachialis.

(5) The *muscular branches*, about four or five in number, are derived from the lateral side of the brachial artery and supply the muscles on the front of the arm.

Musculocutaneous Nerve (Fig. 100).—Its origin from the lateral cord of the brachial plexus has been examined. It passes obliquely downwards and lateralwards, supplies a branch to the coracobrachialis and then pierces the

muscle. Continuing its course downwards and lateral-wards it passes between the biceps brachii in front and the brachialis behind, supplies filaments to both the muscles and reaches the lateral border of the tendon of the biceps brachii at the bend of the elbow. There it perforates the deep fascia and is continued down into the forearm as the lateral antibrachial cutaneous nerve (p. 549).

Median Nerve.—Its origin in the axilla by two heads, viz., a lateral head derived from the lateral cord and a medial head derived from the medial cord of the brachial plexus has been examined (p. 527). The two heads unite either in front of or on the lateral side of the third portion of the axillary artery. The nerve then descends on the lateral side of the brachial artery, crosses that vessel at about the middle of the arm runs down along its medial side to the bend of the elbow lying in front of the brachialis and covered by the lacertus fibrosus. It gives off no branch in the arm.

Ulnar Nerve.—Its origin from the medial cord of the brachial plexus has been examined (p. 536). It runs downwards along the medial side of the axillary and brachial arteries to the middle of the arm. It then passes backwards and pierces the medial intermuscular septum with the superior ulnar collateral artery. It then descends along the back part of the septum to the interval between the medial epicondyle of the humerus and the olecranon process. It gives off no branch in the arm.

Medial antibrachial cutaneous Nerve.—Its origin from the medial cord of the brachial plexus has been noted (p. 536). It descends along the medial side of the axillary and brachial arteries and pierces the deep fascia at about the middle of the arm. The rest of its distribution has been seen (p. 548). Before it perforates the deep fascia it gives off a cutaneous branch which supplies the skin over the biceps brachii as low down as the elbow.

The **Medial Brachial Cutaneous Nerve** is also derived from the medial cord of the brachial plexus. Its course

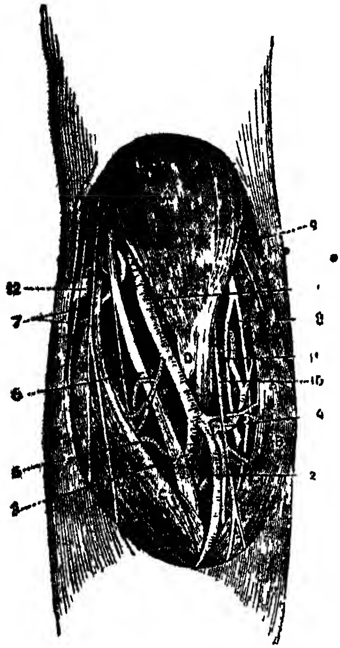


Fig. 106.—Dissection of the cubital fossa.

A. Biceps brachii.
B. Brachioradialis.
C. Pronator teres.
D. Lacertus fibrosus.
1. Brachial artery
2. Radial artery.
3. Ulnar artery.
4. Radial recurrent artery.
5. Anterior ulnar recurrent artery.
6. Median nerve
7. Medial antibrachial cutaneous nerve.
8. Superficial branch of radial nerve.
9. Nerve to brachioradialis.
10. Musculo cutaneous nerve.
11. Deep branch of radial nerve.
12. Lymphatic gland.

along the medial side of the axillary vein and its communicating twig to the intercostobrachial nerve have been noted (p. 527). It continues downwards along the medial side of the brachial artery and perforates the deep fascia at about the middle of the arm. The rest of its course has been already seen (p. 548).

Cubital Fossa (Anticubital space).—The dissector should observe that there is a triangular space at the bend of the elbow, the base of which is directed upwards towards the humerus and is represented by a line joining the two epicondyles of the humerus; the *medial boundary*

is formed by the pronator teres and the *lateral boundary* by the brachioradialis. The *apex* of this space corresponds to the meeting of the two muscles below. The structures which form the coverings or *roof* of the space have been already seen. These are :—the skin, the superficial fascia, the deep fascia with the lacertus fibrosus, the median cubital vein or the median basilic and median cephalic veins, the lateral and medial antibrachial cutaneous nerves. The contents proper of the fossa are :—(1) the termination of the brachial artery with its venæ comitantes in the centre and its bifurcation into the radial and ulnar arteries; (2) the median nerve lying on the medial side of the artery ; and (3) the tendon of the biceps brachii lying lateral to the vessel. Other structures will be seen overlapped by the medial and lateral boundaries of the fossa. Thus by pulling the brachioradialis a little lateralwards and dissecting the interval between it and the brachialis, the radial nerve and, in well injected subjects, the anastomosis between the radial recurrent artery and the terminal branch of the arteria profunda brachii will be seen. By pulling the pronator teres a little medialwards the anastomosis between the anterior branch of the inferior ulnar collateral artery and the anterior ulnar recurrent artery will be seen. Clean the fatty tissue of the space and study the floor of the fossa. The *floor* is formed by two muscles, the brachialis and the supinator.

THE BACK OF THE ARM.

Remove the deep fascia from the back of the arm. The triceps brachii is exposed.

The **Triceps Brachii** (Fig. 101) arises by three heads, a long head, a lateral head, and a medial head. The *long head* arises from the infraglenoid tuberosity of the scapula

by a flattened tendon. The *lateral head* arises from the posterior surface of the body of the humerus extending from the insertion of the teres minor to the upper margin of the radial sulcus and from the lateral intermuscular septum. The *medial head* arises from the posterior surface of the body of the humerus below the radial sulcus and from both the intermuscular septa. The three heads unite near the middle of the arm to form a fleshy mass which is inserted by a tendon, developed on the surface of the muscle, into the back part of the superior surface of the olecranon. An expansion of the tendon is prolonged laterally over the anconæus and is blended with the deep fascia of the forearm. Some fibres of the medial head have a direct fleshy insertion into the olecranon in front of the tendinous insertion. The muscle is supplied by branches from the radial nerve.

A few of the deep fibres from the lower part of the triceps brachii are inserted into the posterior part of the articular capsule of the elbow-joint constituting the muscle known as *subanconæus.*

The radial nerve and the arteria profunda brachii should now be exposed and traced; and for this purpose the lateral head of the triceps brachii bordering upon the radial sulcus should be divided.

The **Radial Nerve** (Musculospiral nerve) is the largest branch of the brachial plexus and may be regarded as the direct continuation downwards of its posterior cord. At first it descends behind the axillary artery and the upper part of the brachial artery. It then proceeds backwards and passes with the arteria profunda brachii along the radial sulcus of the humerus between the lateral and medial heads of the triceps brachii. Reaching the lateral side of the limb it pierces the lateral intermuscular septum to gain the front aspect of the arm. It then passes downwards in the interval between the brachialis medially

and the brachioradialis and extensor carpi radialis longus laterally to the front of the lateral epicondyle of the humerus where it divides into two terminal branches, superficial and deep (Figs. 105, 108).

Branches.—The radial nerve gives off muscular, cutaneous and terminal branches. At the back aspect of the arm the *muscular branches* supply the three heads of the triceps brachii and the anconæus. The nerve to the anconæus is a slender branch which can be traced through the medial head of the triceps to end in the anconæus. At the front aspect of the arm the muscular branches supply the lateral part of the brachialis and the brachioradialis and extensor carpi radialis longus. The *cutaneous branches*, viz., the posterior brachial cutaneous and dorsal antibrachial cutaneous nerves have been already studied (p. 548). The terminal branches will be examined later on.

The *arteria profunda brachii* has been seen to reach the radial sulcus of the humerus. Along that sulcus it passes to the lateral side of the arm accompanied by the radial nerve and at the back part of the lateral intermuscular septum gives off the *radial collateral branch* (posterior branch of the superior profunda). The main artery then pierces the lateral intermuscular septum with the radial nerve and its course along the front aspect of the arm has been noted (p. 556). The *radial collateral branch* runs downwards along the back aspect of the lateral intermuscular septum to the back part of the lateral epicondyle of the humerus and anastomoses with the interosseous recurrent artery. Across the back part of the humerus it forms an anastomotic arch with the inferior ulnar collateral artery. To expose this anastomotic arch divide the triceps brachii above the olecranon. On raising the muscle the arterial arch will be seen lying between the muscle and the posterior aspect of the humerus

above the olecranon fossa. At the back part of the arm the arteria profunda brachii gives off *muscular branches* to the three heads of the triceps brachii, and another branch, which ascends between the long and lateral heads of the triceps brachii to anastomose with the posterior humeral circumflex artery.

The *inferior ulnar collateral artery* has been seen to pierce the medial intermuscular septum and reach the back aspect of the arm. Here it gives off a branch which passes downwards to anastomose with the posterior ulnar recurrent artery behind the medial epicondyle of the humerus. It then turns laterally between the posterior surface of the humerus and the medial head of the triceps brachii and completes the anastomotic arch with the radial collateral branch of the arteria profunda brachii.

As the triceps has been divided above the olecranon the insertion of the subanconæus can now be examined.

THE HUMERAL ARTICULATION OR SHOULDER-JOINT.

The shoulder-joint is an enarthrodial or ball-and-socket joint. The bones entering into the formation of this joint are the glenoid cavity of the scapula and the head of the humerus. The ligaments of this articulation should now be studied. Clean the articular capsule by carefully separating the remains of the muscles surrounding it.

The **Articular Capsule** (Fig. 107) encircles the joint on all sides, being attached above to the circumference of the glenoid cavity beyond the glenoidal labrum and to the labrum itself. Below it is attached to the anatomical neck of the humerus. The capsule is very loose; when

all the muscles surrounding it are divided the articular surfaces can be drawn apart for about an inch. Atmos-

Fig. 107.—Ligaments of the scapula and shoulder-joint.

1. Acromioclavicular ligament.
2. Trapezoid ligament.
3. Conoid ligament.
4. Coracoacromial ligament.
5. Superior transverse ligament of scapula.
6. Articular capsule.
7. Coracohumeral ligament.
8. Long tendon of biceps brachii.

pheric pressure and the muscles surrounding the joint keep the articular surfaces in apposition. It usually presents three apertures: one is placed near the root of the coracoid process through which the synovial stratum of the joint protrudes in the form of a bursa beneath the tendon of the subscapularis; the second is situated between the two tubercles of the humerus through which the long tendon of the biceps passes out of the capsule carrying with it a tubular prolongation of the synovial stratum into the intertubercular sulcus; the third, which is not constant, is placed on the posterior aspect of the capsule and permits the protrusion of the synovial stratum of the joint in the form of a bursa under cover of the tendon of the infraspinatus. The muscles

in immediate relation with the capsule should be noted. Thus the supraspinatus lies above; the infraspinatus and teres minor are placed behind; the long head of the triceps lies below; and the subscapularis in front.

Open the posterior part of the capsule and through the opening force out the head of the humerus and remove it with a saw. Three accessory bands strengthening the articular capsule are seen.

Glenohumeral ligaments.—These are three accessory bands which extend from the margin of the glenoid cavity to the humerus. The first of these (Flood's ligament) extends from the medial margin of the glenoid cavity to the lesser tubercle of the humerus. The second (Schlemm's ligament) passes from the lower margin of the glenoid cavity to the lower part of the anatomical neck of the humerus. The third band (glenohumeral ligament) is attached above to the apex of the glenoid cavity and, running parallel and medial to the long tendon of the biceps brachii, is fixed to the lesser tubercle of the humerus.

The **Coracohumeral Ligament** strengthens the capsule on its superior aspect. It s attached above to the lateral border of the root of the coracoid process. It passes downwards and lateralwards in front of the greater tubercle of the humerus and becomes blended with the tendon of the supraspinatus.

The **Transverse Humeral Ligament** stretches across the upper part of the intertubercular sulcus between the greater and lesser tubercles.

The **Glenoidal Labrum** (glenoid ligament) consists of a fibro-cartilaginous band attached to the free margin of the glenoid cavity. At the upper part of the glenoid cavity it blends with the origin of the long tendon of the biceps brachii. It's free margin is thinner than the attached margin. It serves to deepen the glenoid cavity.

The **Synovial Stratum** lines the interior of the articular capsule and the glenoidal labrum. It encloses the long tendon of the biceps brachii in a tubular sheath which protrudes into the intertubercular sulcus. Its protrusion beneath the subscapularis and also sometimes under cover of the infraspinatus have been already referred to.

The dissector should now carefully examine the origin of the long tendon of the biceps brachii where it is blended with the glenoidal labrum. Its course through the capsule and exit from the intertubercular sulcus should also be examined.

THE FRONT OF THE FOREARM.

The dissection of this region comprises an examination of the following structures :—

Fasciæ	1. Superficial. 2. Deep.	
Muscles	1. Pronator teres. 2. Flexor carpi radialis. 3. Palmaris longus. 4. Flexor carpi ulnaris. 5. Flexor digitorum sublimis.	Superficial group.
	6. Flexor digitorum profundus. 7. Flexor pollicis longus. 8. Pronator quadratus.	Deep group.
Vessels	1. Radial artery and its branches. 2. Ulnar artery and its branches. 3. Volar interosseous artery.	
Nerves	1. Cutaneous. 2. Superficial branch of the radial nerve. 3. Median nerve. 4. Ulnar nerve. 5. Volar interosseous nerve.	

The skin of the front of the forearm has been already reflected and the superficial fascia and the superficial veins have been examined.

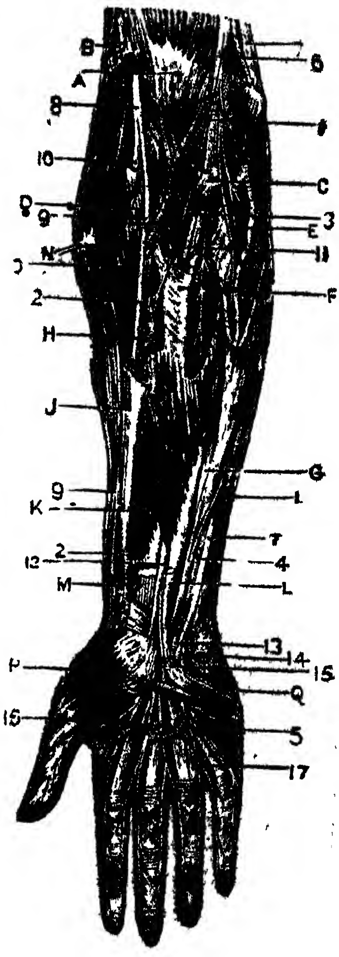
The **Cutaneous Nerves** which are prolonged from the arm to the forearm have been traced. The origins of two other cutaneous nerves just above the wrist are to be secured and their continuations into the palm will be traced during the dissection of the palm. These are: (1) the palmar cutaneous branch of the ulnar nerve above the ulnar side of the wrist and (2) the palmar cutaneous branch of the median nerve above the median line of the wrist.

The **Antibrachial Fascia** (deep fascia of the forearm) is a strong membrane which envelopes the muscles of the forearm. Above it is continuous with the brachial fascia. Above and in front it is strengthened medially by the lacertus fibrosus. Behind it is attached to the olecranon and the posterior border of the ulna and is strengthened by an expansion from the tendon of the triceps brachii. Below it is thickened in front and continuous with the volar carpal and transverse carpal ligaments in front of the wrist. Below and behind it is thickened to form the dorsal carpal ligament which binds the extensor tendons. It gives origin to the muscles at the upper part of the forearm and from its deep surface septa are given off which pass between the muscles.

Reflect the deep fascia preserving the two cutaneous nerves which perforate it just above the wrist. Clean the muscles on the front and medial aspects of the forearm. These muscles are arranged in two groups, a superficial and a deep. The superficial group arises by a common tendon from the front of the medial epicondyle of the humerus and consists of the following muscles from the lateral to the medial side :—the pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris. The flexor digitorum sublimis lies on a deeper plane partially covered by these muscles.

The **Pronator Teres** (Pronator radii teres) arises by two heads, a humeral and an ulnar. The *humeral*

Fig. 108.—Superficial dissection of the front of the forearm and hand (from Hirschfeld and Leveille).



A. Biceps brachii.
B. Brachioradialis.
C. Pronator teres.
D. Supinator.
E. Flexor carpi radialis.
F. Flexor digitorum sublimis.
G. Flexor digitorum profundus.
H. Tendon of pronator teres.
I. Tendon of flexor carpi ulnaris.
J. Tendon of brachioradialis
K. Flexor pollicis longus.
L. Tendon of palmaris longus.
M. Tendon of flexor carpi radialis.
N. Extensor carpi radialis longus.
O. Extensor carpi radialis brevis.
P. Abductor pollicis brevis.
Q. Palmaris brevis.
1. Brachial artery.
2. Radial artery.
3. Ulnar artery.
4. The same.
5. Superficial volar arch.
6. Median nerve.
7. Ulnar nerve.
8. Radial nerve.
9. Superficial branch of radial nerve.
10. Deep branch of radial nerve.
11. Volar interosseous nerve.
12. Median nerve.
13. Superficial branch of ulnar nerve.
14. Deep branch of ulnar nerve.
15. Palmar cutaneous branch of median nerve.
16. Digital branches of median nerve.
17. Digital branches of ulnar nerve.

head arises (1) from the anterior aspect of the medial epicondyle of the humerus by the common tendon, (2) from the antibrachial fascia covering it, and (3) from the intermuscular septum between it and the flexor carpi radialis. The *ulnar head* is deeply situated and arises from the medial side of the coronoid process of the ulna. The median nerve passes between the two heads of origin. The muscle is inserted into a rough impression at the middle of the lateral surface of the radius. It is supplied by the median nerve.

The **Flexor Carpi Radialis** arises (1) from the medial epicondyle of the humerus by the common tendon, (2) from the deep surface of the antibrachial fascia, and (3) from the intermuscular septa between it and the adjacent muscles. The muscle ends below the middle of the forearm in a tendon which runs through the lateral side of the transverse carpal ligament and along the groove on the volar surface of the greater multangular bone. It is inserted into the volar aspects of the bases of the second and third metacarpal bones—the slip to the third metacarpal bone being the smaller. The terminal portion of this tendon will be seen during the dissection of the palm. It is supplied by the median nerve.

The **Palmaris Longus** arises (1) from the medial epicondyle of the humerus by the common tendon, (2) from the deep surface of the antibrachial fascia, and (3) from the intermuscular septa on either side of it. It terminates in a long narrow tendon which passes in front of the transverse carpal ligament and is inserted into the central portion of the palmar aponeurosis. It is supplied by the median nerve.

The **Flexor Carpi Ulnaris** arises (1) from the medial epicondyle of the humerus by the common tendon (humeral head), (2) from the medial border of the olecranon and the upper two-thirds of the posterior border

of the ulna (ulnar head), (3) from the deep surface of the antibrachial fascia, and (4) from the intermuscular septum between it and the flexor digitorum sublimis. The muscle terminates in a tendon which is inserted into the pisiform bone. The ulnar nerve and the posterior ulnar recurrent artery pass between the humeral and ulnar heads. It is supplied by the ulnar nerve.

The **Flexor Digitorum Sublimis** is partly covered by the other muscles of the superficial group. It arises (1) from the medial epicondyle of the humerus by the common tendon, (2) from the medial side of the coronoid process of the ulna, (3) from the oblique line of the radius, (4) from the ulnar collateral ligament of the elbow-joint, and (5) from the intermuscular septa separating it from the other muscles of the superficial group. The fleshy mass soon divides into four tendons of which two lie superficially. These two superficial tendons are meant for the middle and ring fingers which may be ascertained by pulling them. The other two tendons lie deep and are meant for the index and little fingers. These tendons are enclosed by a mucous sheath and pass under cover of the transverse carpal ligament to the palm. The disposition of the tendons in the palm and their mode of insertion into the phalanges will be examined during the dissection of the palm. This muscle is supplied by the median nerve.

Now study the vessels and nerves exposed during the superficial dissection of the front of the forearm. These are the radial artery with its branches, the ulnar artery with its branches, the median nerve, the ulnar nerve, and the superficial branch of the radial nerve.

The **Radial Artery** begins in the cubital fossa at the bifurcation of the brachial artery opposite the neck of the radius. It descends along the radial side of the volar aspect of the forearm up to the wrist and then

winds round its lateral border to reach the dorsum of the hand where it will be examined subsequently. In the upper part of the forearm it is covered by the fleshy portion of the brachioradialis but lower down it is superficial being covered by the skin and fasciæ and lies between the tendons of the brachioradialis and flexor carpi radialis. Owing to its superficial position above the wrist the pulse is usually felt in the radial artery at this situation. Its posterior relations from above downwards are : the tendon of the biceps brachii, the supinator, the insertion of the pronator teres, the radial origin of the flexor digitorum sublimis, the flexor pollicis longus, the pronator quadratus, and the lower end of the radius. The superficial branch of the radial nerve is placed close to the lateral side of the artery in the middle third of the forearm. The radial artery is accompanied by the venæ comites throughout its entire course.

Branches.—The radial artery gives off the following branches in the forearm :—(1) The *radial recurrent artery.* It arises from the commencement of the radial artery and passes lateralwards upon the supinator muscle. Then it ascends between the brachialis and the brachioradialis to anastomose with the terminal portion of the arteria profunda brachii. It supplies the neighbouring muscles. (2) The *volar carpal branch.* It arises opposite the lower border of the pronator quadratus and passes medialwards beneath the flexor tendons to anastomose with the volar carpal branch of the ulnar artery. (3) The *superficial volar branch.* It arises from the radial artery before this vessel winds round the wrist. In the palm it passes either across or through the short muscles of the thumb. It may end in those muscles or may continue its course to join the lateral end of the superficial volar arch. (4) The *muscular branches.* These are many twigs supplying the muscles on the lateral side of the volar aspect of the forearm.

The **Ulnar Artery** begins at the bifurcation of the brachial and is larger than the radial artery. At first it runs obliquely downwards and medialwards and reaches the ulnar side of the forearm. Then it descends straight downwards to the wrist and passes across the front of the medial end of the transverse carpal ligament to enter the palm. It is accompanied by two venæ comites.

Observe the *relations of the upper oblique portion* of the artery. It is deeply placed lying underneath the pronator teres, the flexor carpi radialis, the palmaris longus and the flexor digitorum sublimis. The median nerve crosses the artery from the medial to the lateral side, the ulnar head of the pronator teres intervening between them. The ulnar nerve is not in immediate relation with the oblique portion of the artery, but gains its medial side at the commencement of its vertical course. Posteriorly the oblique portion of the artery rests on the brachialis and the flexor digitorum profundus.

Now study the *relations of the lower vertical portion* of the artery. In the upper part it is covered by the flexor carpi ulnaris. Lower down a little above the wrist it is superficial being covered only by the skin and the superficial and deep fasciæ and is placed between the tendon of the flexor carpi ulnaris medially and those of the flexor digitorum sublimis laterally. The ulnar nerve lies close to the medial side of the artery in the lower two-thirds of the forearm. Posteriorly the artery lies upon the flexor digitorum profundus and at the wrist upon the transverse carpal ligament.

Branches.—The ulnar artery gives off the following branches in the forearm :—(1) The *anterior ulnar recurrent artery*. It is given off from the ulnar artery soon after its origin. It passes upwards between the pronator teres and the brachialis, supplies these muscles and anastomoses

with the inferior ulnar collateral artery in front of the medial epicondyle of the humerus. (2) The *posterior ulnar recurrent artery* which is larger and arises a little below the preceding or sometimes by a common trunk with it. It passes medialwards and backwards beneath the flexor digitorum sublimis and then ascends along the interval between the medial epicondyle of the humerus and the olecranon to anastomose with the superior and inferior ulnar collateral arteries. It supplies the neighbouring muscles and the elbow-joint. (3) The *common interosseous artery* is a short thick trunk which arises below the preceding branch and passes backwards to reach the upper border of the interosseous membrane of the forearm where it divides into a volar and a dorsal branch. These will be traced later on. (4) The *volar carpal branch* (anterior carpal) runs medialwards in front of the carpus beneath the flexor tendons and anastomoses with the volar carpal branch of the radial artery forming an anastomotic arch. (6) The *dorsal carpal branch* arises above the pisiform bone and winds round the medial border of the wrist. It will be traced during the dissection of the dorsum of the forearm. (7) The *muscular branches* supply the muscles of the ulnar side of the forearm.

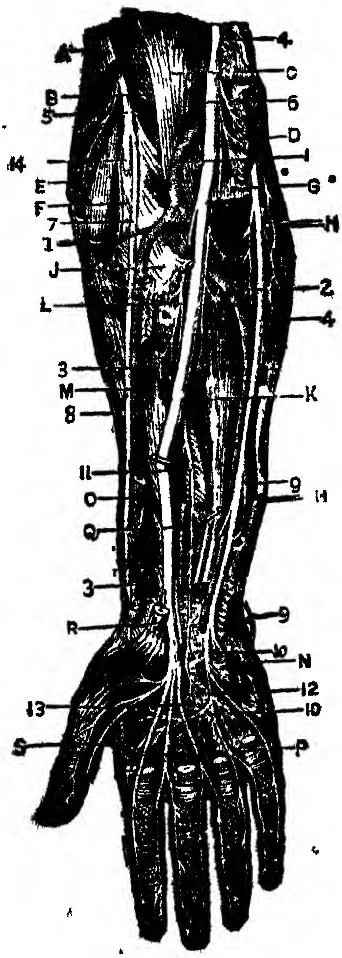
The **Radial Nerve** has been seen to divide into a superficial and a deep branch under cover of the brachioradialis where it forms the lateral boundary of the cubital fossa. The *superficial branch* of the radial nerve (radial nerve) runs downwards over the supinator covered by the brachioradialis. It accompanies the radial artery lying on its lateral side in the upper two-thirds of its course. It then winds round the lateral side of the forearm to reach its dorsal aspect and will be studied later on. The *deep branch* of the radial nerve (posterior interosseous nerve) passes through the supinator to reach the dorsal aspect of the forearm and will be subsequently examined.

The **Median Nerve** enters the forearm between the two heads of the pronator teres. It is necessary that the dissector should cut the humeral head of the muscle so that the nerve may be traced in its entirety in the forearm. Its relation to the ulnar artery has been noted. In the forearm it runs downwards under cover of the flexor digitorum sublimis and in front of the flexor digitorum profundus. About two inches above the wrist it becomes superficial appearing between the tendons of the flexor digitorum sublimis medially and the tendon of the flexor carpi radialis laterally. It then passes behind the transverse carpal ligament to the palm of the hand. The arteria mediana, which is derived from the volar interosseous artery, accompanies the median nerve in the forearm. The *branches* given off from the median nerve in the forearm are: (1) *muscular branches* to the pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor digitorum sublimis; (2) the *palmar cutaneous branch* which has already been secured near the wrist; and (3) the *volar interosseous nerve* which is distributed to the deep muscles on the front of the forearm.

Ulnar Nerve.—The course of this nerve in the arm has been studied (p. 550). It passes into the forearm between the two heads of origin of the flexor carpi ulnaris along the sulcus nervi ulnaris on the back part of the medial epicondyle of the humerus. It descends along the front aspect of the ulnar side of the forearm being covered by the flexor carpi ulnaris and is placed upon the flexor digitorum profundus. Near the wrist it becomes superficial being covered by the skin and the fasciæ on the lateral side of the tendon of the flexor carpi ulnaris. It then crosses the transverse carpal ligament and passes to the palm of the hand. Its relation to the ulnar artery has been already described. The *branches* of the ulnar nerve in the forearm are:—(1) *articular branches* which

enter the back part of the elbow-joint; (2) *muscular branches* which supply the flexor carpi ulnaris and the

Fig. 109.—Deep dissection of the front of the fore-arm and hand (from Hirschfeld and Leveille).



A. Brachioradialis.
B. Brachialis.
C. Biceps brachii.
D. Pronator teres and flexor carpi radialis (cut).
E. Extensor carpi radialis longus.
F. Supinator.
G. Flexor digitorum sublimis.
H. Flexor carpi ulnaris.
I. Extensor carpi radialis brevis.
J. Radial origin of flexor digitorum sublimis
K. Flexor digitorum profundus.
L. Pronator teres.
M. Flexor pollicis longus.
N. Abductor digiti quinti.
O. Tendon of brachioradialis.
P. One of the lumbricales.
Q. Pronator quadratus.
R. Tendon of flexor carpi radialis
S. Adductor pollicis (transverse portion).
1 Brachial artery.
2. Ulnar artery.
3. Radial artery.
4. Ulnar nerve.
5. Radial nerve.
6. Median nerve.
7. Superficial branch of radial nerve.
8. Radial nerve.
9. Dorsal branch of ulnar nerve.
10. Deep branch of ulnar nerve.
11. Volar interosseous nerve.
12. Digital branches of ulnar nerve.
13. Digital branches of median nerve.
14. Dorsal interosseous nerve.

medial half of the flexor digitorum profundus; (3) the *palmar cutaneous branch* which springs about the middle of the forearm, descends in front of the ulnar artery and perforates the deep fascia close to the wrist; and (4) the *dorsal branch* which issues about two inches above the wrist and passes to the dorsum of the forearm by winding round its ulnar side under cover of the flexor carpi ulnaris.

Now study the deep group of muscles on the front of the forearm. These are the flexor digitorum profundus on the ulnar side, the flexor pollicis longus on the radial side and the pronator quadratus placed beneath these two muscles above the wrist. On the front aspect of the interosseous membrane of the forearm and between the flexor digitorum profundus and the flexor pollicis longus the volar interosseous vessels and nerve proceed downwards.

The **Flexor Digitorum Profundus** arises (1) from the upper three-fourths of the volar and medial surfaces of the body of the ulna; (2) from a depression on the medial side of the coronoid process; (3) from the ulnar side of the volar aspect of the interosseous membrane; and (4) from the dorsal border of the body of the ulna by an aponeurosis common to it and the flexor carpi ulnaris. The muscle divides into four tendons which pass beneath the transverse carpal ligament to the palm. It should be noted that of the four tendons, the tendon for the index finger becomes separate from the others in the forearm. The lateral half of the muscle is supplied by the volar interosseous branch of the median nerve and the medial half by the ulnar nerve.

The **Flexor Pollicis Longus** arises (1) from the volar surface of the radius, extending from the oblique line above to the upper margin of the pronator quadratus below; (2) from the radial side of the volar aspect of the interosseous membrane; and occasionally (3) from the

medial margin of the coronoid process. The muscle ends in a tendon which passes beneath the transverse carpal ligament to the palm. It is supplied by the volar interosseous branch of the median nerve.

The Pronator Quadratus covers the lower part of the volar aspects of the radius and ulna. It arises from the pronator ridge and from the adjacent volar surface of the ulna at its lower part. It is inserted into the volar surface of the lower fourth of the radius as far as its lateral border. It is supplied by the volar interosseous nerve which enters its deep surface.

Volar Interosseous Artery (Anterior interosseous artery).—Its origin from the common interosseous branch of the ulnar artery has been noticed. It descends along the volar aspect of the interosseous membrane lying between the flexor digitorum profundus medially and the flexor pollicis longus laterally. At the upper margin of the pronator quadratus it perforates the interosseous membrane and reaches the back part of the forearm where its anastomosis with the dorsal interosseous artery will be seen later on. It gives off (1) *muscular branches* to the three deep muscles of the front of the forearm; (2) *nutrient branches* to the radius and ulna; (3) the *arteria mediana* which accompanies the median nerve and supplies it; and (4) the *anterior communicating branch* which issues before the artery pierces the interosseous membrane and descends under cover of the pronator quadratus to join the volar carpal network.

Volar Interosseous Nerve (Anterior interosseous nerve).—Its origin from the median nerve has been noted. It accompanies the volar interosseous artery on the volar aspect of the interosseous membrane and supplies the flexor pollicis longus and the lateral half of the flexor digitorum profundus. It then passes behind the pronator

quadratus, supplies twigs to it and terminates in the wrist-joint.

THE BACK AND LATERAL SIDE OF THE FORE-ARM AND THE DORSUM OF THE HAND.

The following structures require to be examined in this dissection:—

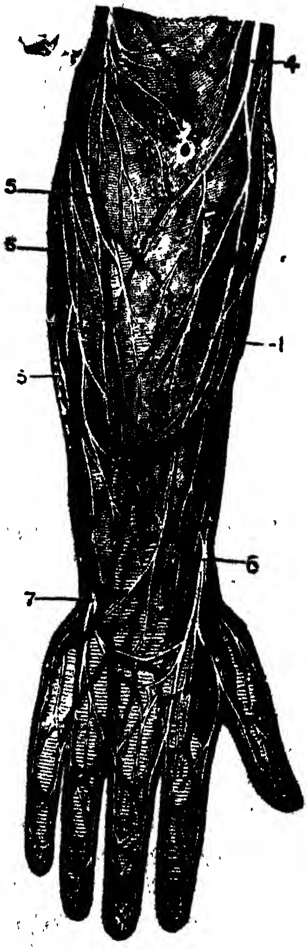
Muscles	1. Brachioradialis. 2, 3. Extensores carpi radialis longus and brevis. 4. Extensor digitorum communis. 5. Extensor digiti quinti proprius. 6. Extensor carpi ulnaris. 7. Anconæus.	Superficial group.
	8. Supinator. 9. Abductor pollicis longus. 10. Extensor pollicis brevis. 11. Extensor pollicis longus. 12. Extensor indicis proprius.	Deep group.
Vessels	1. Superficial veins. 2. Dorsal interosseous artery. 3. Terminal part of volar interosseous artery. 4. Radial artery with its branches at the back of the wrist and dorsum of the hand.	
Nerves	1. Cutaneous nerves. 2. Deep branch of the radial nerve.	

Dorsal carpal ligament.

Remove the skin from the back of the forearm and the dorsum of the hand. The skin should also be reflected from the dorsal aspects of the thumb and other fingers.

Cutaneous Nerves.—The following cutaneous nerves on the back of the forearm have been already noted. (1) The *ulnar branch* of the medial antibrachial cutaneous nerve which encroaches on the ulnar side of the back of the forearm from its medial aspect; (2) the *dorsal*

branch of the lateral antibrachial cutaneous nerve which encroaches on the radial side of the back of the forearm



from its lateral aspect ; (3) the *lower branch* of the dorsal antibrachial cutaneous nerve which descends along the middle of the dorsum of the forearm as far as the wrist. Two other nerves require to be examined : (1) The *dorsal branch of the ulnar nerve* appears on the ulnar side of the dorsum of the forearm by winding round its medial border about two inches above the wrist. Piercing the deep fascia it descends along the ulnar side of the back of the wrist and hand. It then divides into two dorsal digital branches and a communicating branch. Of the two *dorsal digital branches* one supplies the medial margin of the dorsum of the hand and the little finger ; the other is distributed to the contiguous sides of the little and ring fingers on the dorsal aspect. The *communicating branch* joins the twig from the superficial branch of the radial nerve which supplies

Fig. 110.—Cutaneous dissection of the back of the forearm and dorsum of the hand (from Hirschfeld and Leveillé).

1' Venous arch on the dorsum of the hand.
1. Cephalic vein.
4. Dorsal antibrachial cutaneous branch of radial nerve.
5. Ulnar branch of medial antibrachial cutaneous nerve.
6. Superficial branch of radial nerve.
7. Dorsal branch of ulnar nerve.

the contiguous sides of the ring and middle fingers on their dorsal aspects. Minute twigs are also supplied to the skin on the ulnar side of the dorsum of the hand. (2) The *superficial branch of the radial nerve* has been traced to the point where it turns round the radial side of the forearm at the junction of its lower and middle thirds to gain the dorsal aspect. It then pierces the deep fascia and divides into a lateral and a medial branch. The lateral branch is the smaller and is distributed to the skin at the radial border of the hand and the thumb and communicates with the volar branch of the lateral antibrachial cutaneous nerve. The medial branch divides into four dorsal digital branches: the first supplies the ulnar side of the thumb; the second, the radial side of the index finger; the third, the contiguous sides of the index and middle fingers; and the fourth, the adjoining sides of the middle and ring fingers. The fourth digital branch is joined by the communicating filament from the dorsal branch of the ulnar nerve.

Superficial Veins.—The *dorsal digital veins* proceed along the dorsal aspect of the digits and end opposite the heads of the metacarpal bones in *dorsal metacarpal veins*. These join with each other and opposite the middle of the metacarpal bones form a *dorsal venous network*. From the radial end of this venous network the *cephalic vein* commences and from the ulnar side of it the *basilic vein* takes origin. The cephalic vein winds round the radial border and the basilic vein round the ulnar border of the forearm and both reach its volar aspect.

Remove the deep fascia carefully, noting that the superficial muscles take their origin from the deep surface of

the fascia. Preserve the thickened band of the fascia on the dorsum of the wrist which forms the dorsal carpal ligament. The superficial group of muscles on the radial side and back of the forearm are now to be studied. These muscles are described below commencing from the radial to the ulnar side of the forearm.

The **Brachioradialis** (supinator longus) arises from the upper two-thirds of the lateral supracondylar ridge of the humerus and from the lateral intermuscular septum attached to it. It ends in a flat tendon at about the middle of the forearm and is inserted into the antero-lateral aspect of the base of the styloid process of the radius. It is supplied by a branch from the radial nerve.

The **Extensor Carpi Radialis Longus** arises from the lower third of the lateral supracondylar ridge of the humerus and from the lateral intermuscular septum. The muscle terminates at about the junction of the upper with the middle third of the forearm in a tendon which passes under cover of the dorsal carpal ligament to be inserted into the dorsal surface of the base of the second metacarpal bone. It is supplied by the radial nerve.

The **Extensor Carpi Radialis Brevis** arises (1) from the lateral epicondyle of the humerus by the common tendon of origin of the extensor muscles, (2) from the radial collateral ligament of the elbow-joint, (3) from the deep fascia covering it, and (4) from the intermuscular septa separating it from the adjacent muscles. It ends about the middle of the forearm in a tendon, which passes under cover of the dorsal carpal ligament in the same compartment with the extensor carpi radialis longus and is inserted into the dorsal aspect of the base of the third metacarpal bone. It is supplied by the deep branch of the radial nerve.

The **Extensor Digitorum Communis** arises (1) from the lateral epicondyle of the humerus by the common

tendon, (2) from the deep fascia of the forearm, and (3) from the intermuscular septa between it and the

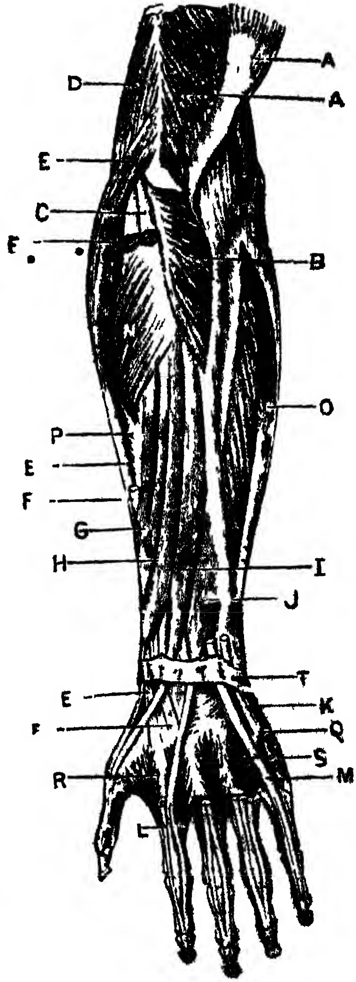


Fig. 111.—Deep muscles of the back of the fore-arm (from Sappey).

A. Triceps brachii

B. Anconæus.

C. Common tendon of extensor digitorum communis, extensor digiti quinti proprius and extensor carpi ulnaris.

D. Brachioradialis.

E. Extensor carpi radialis longus.

F. Extensor carpi radialis brevis.

G. Abductor pollicis longus.

H. Extensor pollicis brevis.

I. Extensor pollicis longus.

J. Extensor indicis proprius.

K. Insertion of extensor carpi ulnaris.

L. Dorsal expansion of extensor digitorum communis and extensor indicis proprius.

M. Tendon of extensor digiti quinti proprius.

N. Supinator.

O. Tendon of flexor carpi ulnaris.

P. Insertion of pronator teres.

Q. Abductor digiti quinti.

R. First dorsal interosseous.

S. Fourth dorsal interosseous muscle.

T. Dorsal carpal ligament.

adjacent muscles. At the lower third of the forearm it divides into four tendons which pass under cover of the

dorsal carpal ligament in the same compartment with the extensor indicis proprius and enclosed in one mucous sheath. On the dorsum of the hand the four tendons diverge from each other and proceed to the dorsal aspects of the four fingers. The tendon for the index finger is joined on its ulnar side by the tendon of the extensor indicis proprius. The tendon for the little finger is joined on its ulnar side by the tendon of the extensor digiti quinti proprius. The tendons for the middle and ring fingers run singly. Each tendon covers the dorsal aspect of the metacarpophalangeal articulation and expands over the dorsum of the first phalanx where it receives the insertions of the lumbricales and interossei. At the base of the second phalanx each tendon divides into three slips, one intermediate and two collateral. The *intermediate slip* is inserted into the dorsum of the base of the second phalanx. The *collateral slips* converge over the dorsum of the second phalanx and reunite to form one slip which is inserted into the dorsum of the base of the last phalanx. Over the lower part of the dorsum of the hand the tendon to the ring finger is connected on either side with the tendons to the middle and little fingers by oblique flattened tendinous bands. Sometimes the tendon to the middle finger is also similarly connected with the tendon to the index finger. The muscle is supplied by the dorsal interosseous nerve.

The **Extensor Digiti Quinti Proprius** (extensor minimi digiti) arises from the lateral epicondyle of the humerus by the common tendon and from the intermuscular septa between it and the adjacent muscles. The muscle ends in a tendon which passes through a separate compartment of the dorsal carpal ligament and divides over the dorsum of the hand into two slips, both of which ultimately blend with the expanded tendon of the extensor

digitorum communis proceeding to the little finger. It is supplied by the dorsal interosseous nerve.

The **Extensor Carpi Ulnaris** arises (1) from the lateral epicondyle of the humerus by the common tendon, (2) from the deep fascia, (3) from the intermuscular septum separating it from the preceding muscle, and (4) from the dorsal border of the ulna by an aponeurosis. It ends in a tendon which passes through a separate compartment of the dorsal carpal ligament along the groove between the head of the ulna and its styloid process. Here it is lined by a mucous sheath. It is inserted into the tubercle on the medial side of the base of the fifth metacarpal bone. The muscle is supplied by the dorsal interosseous nerve.

The **Anconæus** is narrow at its origin from the back part of the lateral epicondyle of the humerus but is broad at is insertion into the lateral surface of the olecranon and into the upper fourth of the dorsal surface of the body of the ulna. It is supplied by a long slender twig derived from the radial nerve.

Now study the muscles of the deep group and the dorsal interosseous artery and nerve. To expose these divide the extensor digitorum communis and the extensor digiti quinti proprius at about the middle of the forearm and reflect them without injuring the nerves which supply them.

The **Supinator** (supinator brevis) consists of a superficial layer and a deep layer between which the deep branch of the radial nerve passes. Both the layers arise (1) from the lateral epicondyle of the humerus, (2) from the radial collateral ligament of the elbow-joint, (3) from the annular ligament of the proximal radioulnar articulation, and (4) from the triangular depression below the radial notch of the ulna. The fibres of the muscle turn round the neck and the upper part of the body of the radius and are inserted into the oblique line of the

radius and to the lateral and back part of the body of the bone above the oblique line. It is supplied by the deep branch of the radial nerve which passes through it.

The **Abductor Pollicis Longus** (extensor ossis metacarpi pollicis) arises (1) from the lateral part of the dorsal surface of the body of the ulna below the oblique ridge, (2) from the middle third of the dorsal surface of the radius, and (3) from the interosseous membrane. It passes downwards and lateralwards, crosses the tendons of the extensores carpi radialis longus and brevis and ends in a tendon which passes under cover of the dorsal carpal ligament in the same compartment with the extensor pollicis brevis on the lateral side of the lower end of the radius. It is inserted into the lateral side of the base of the first metacarpal bone. The muscle is supplied by the dorsal interosseous nerve.

The **Extensor Pollicis Brevis** (extensor primi internodii pollicis) arises from the dorsal surface of the body of the radius below the preceding muscle and from the adjacent interosseous membrane. It accompanies the abductor pollicis longus and its tendon passes through the same compartment of the dorsal carpal ligament. It is inserted into the dorsum of the base of the first phalanx of the thumb. It is supplied by the dorsal interosseous nerve.

The **Extensor Pollicis Longus** (extensor secundi internodii pollicis) arises from the lateral part of the dorsal surface of the body of the ulna below the origin of the abductor pollicis longus and from the adjacent interosseous membrane. Its tendon passes under cover of the dorsal carpal ligament through a separate compartment. It is inserted into the dorsal aspect of the base of the last phalanx of the thumb. It is supplied by the dorsal interosseous nerve.

The **Extensor Indicis Proprius** arises from the lateral part of the dorsal surface of the body of the ulna below

the origin of the preceding muscle and from the lower part of the interosseous membrane. Its tendon passes with those of the extensor digitorum communis under cover of the dorsal carpal ligament. The tendon is ultimately blended, opposite the metacarpophalangeal articulation, with the tendon of the common extensor of the digits to the index finger. It is supplied by the dorsal interosseous nerve.

Dorsal Interosseous Artery (Posterior interosseous artery).—Its origin from the common interosseous artery on the volar aspect of the forearm has been observed (p. 574). It passes backwards between the upper border of the interosseous membrane and the oblique cord and appears on the dorsum of the forearm between the supinator and the abductor pollicis longus. It descends between the superficial and deep group of muscles to the dorsum of the wrist where it anastomoses with the terminal part of the volar interosseous artery and with the dorsal carpal branches of the radial and ulnar arteries. The *branches* given off from it are :—(1) The *interosseous recurrent* which arises as soon as the parent trunk appears on the dorsum of the forearm. It ascends under cover of the anconæus to the interval between the lateral epicondyle of the humerus and the olecranon to anastomose with the radial collateral branch of the arteria profunda brachii and with the inferior ulnar collateral artery. (2) *Muscular branches* which supply the neighbouring muscles.

Deep Branch of the Radial Nerve.—The origin of this nerve in front of the forearm has been seen (p. 574). It gains the dorsum of the forearm by passing between the superficial and deep planes of the supinator. It then descends between the superficial and deep groups of muscles to the upper margin of the extensor pollicis longus. Thereafter it passes in front of the muscle and, being

much reduced in size by giving off all its muscular branches, descends on the interosseous membrane as the **dorsal interosseous nerve** to the dorsum of the carpus. Here it terminates in a gangliform enlargement like that seen on the nerve to the teres minor and from this enlargement twigs are given off to the wrist-joint. Before the deep branch of the radial nerve gains the dorsum of the fore-arm it supplies branches to the extensor carpi radialis brevis and the supinator. On the dorsum of the forearm it supplies the remaining muscles, viz., the extensor digitorum communis, extensor digiti quinti proprius, extensor carpi ulnaris, abductor pollicis longus, the two extensors of the thumb, and the extensor indicis proprius.

The **Volar Interosseous Artery** has been traced to the upper border of the pronator quadratus where it perforates the interosseous membrane to gain the dorsum of the forearm. Then it descends to the back of the carpus and anastomoses with the terminal part of the dorsal interosseous artery and with the arch formed by the dorsal carpal branches of the radial and ulnar arteries.

The **Radial Artery** has been traced in front of the forearm as far down as the wrist. Here is winds backwards round the radial border of the carpus lying upon the radial collateral ligament of the wrist-joint and covered by the abductor pollicis longus and extensor pollicis brevis. It then descends upon the navicular and greater multangular bones and, reaching the proximal end of the first interosseous space, dips down between the two heads of the first dorsal interosseous muscle to join the deep volar arch in the palm. It is accompanied by two venæ comites. At this stage of the dissection it gives off the following *branches* :—(1) The *dorsal carpal artery* which arises from the radial artery where it is crossed by the abductor pollicis longus and extensor pollicis brevis.

It passes medialwards along the dorsum of the carpus to anastomose with the dorsal carpal branch of the ulnar

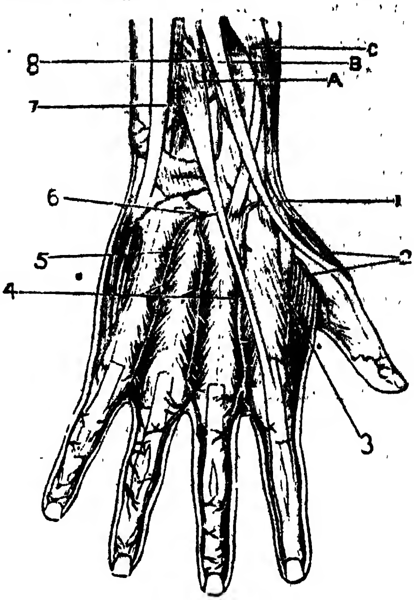


Fig. 112.—The dorsum of the hand.

A. Extensor indicis proprius.
B. Extensor pollicis longus.
C. Extensor pollicis brevis.
1. Radial artery.
2. First dorsal digital arteries for the thumb.
3. Dorsal digital arteries for the index finger.
4. Dorsal metacarpal arteries.
5 Superior perforating artery.
6. Dorsal carpal network.
7. Dorsal interosseous artery.
8. Volar interosseous artery.

artery. (2) The *dorsal digital branches* which are three in number. They arise from the artery before it dips into the palm. The first and second supply respectively the radial and ulnar borders of the dorsum of the thumb. The third supplies the radial side of the dorsum of the index finger. (3) The *first dorsal metacarpal artery.* It arises either from the radial artery or from the dorsal carpal network. It descends along the second interosseous space on the second dorsal interosseous muscle and bifurcates into two dorsal digital branches which supply the contiguous sides of the index and middle fingers on their dorsal aspects.

The **Dorsal Carpal Network** is formed on the dorsum of the carpus by the anastomosis of the dorsal carpal

branches of the radial and ulnar arteries. This anastomotic arch is joined from above by the terminal portions of the volar and dorsal interosseous arteries. The *second* and *third dorsal metacarpal arteries* are given off from this network which descend along the third and fourth interosseous spaces respectively. Each divides into two *dorsal digital branches*. Those of the second supply the contiguous sides of the middle and ring fingers. Those of the third supply the contiguous sides of the ring and little fingers. The first dorsal metacarpal artery sometimes arises from this dorsal carpal network. These dorsal metacarpal arteries are joined by the superior perforating branches of the deep volar arch which emerge between the heads of the dorsal interosseous muscles at the upper part of the interosseous spaces. They also communicate with the common volar digital branches of the superficial volar arch by *inferior perforating branches* which pass between the heads of the metacarpal bones.

The **Dorsal Carpal Ligament** (posterior annular ligament) is a thickened portion of the deep fascia of the forearm which stretches as a fibrous band across the back of the wrist and keeps the tendons in situ. Laterally it is attached to the lateral margin of the lower end of the radius and medially to the styloid process of the ulna and to the triquetral and pisiform bones. From its deep surface processes are given off which are attached to the ridges on the back part of the lower end of the radius so as to form six osseo-fibrous compartments for the tendons at the back of the wrist. Each of these compartments is lined by a separate mucous sheath. Open up each of these compartments and examine them from the lateral to the medial side. The *first* compartment is on the lateral side of the styloid process of the radius and contains the tendons of the abductor pollicis longus and extensor pollicis brevis. The *second* compartment is

on the lateral side of the dorsum of the lower end of the radius and contains the tendons of the extensores carpi radiales longus and brevis. The *third* compartment is formed by the narrow groove directed obliquely downwards and lateralwards about the middle of the back of the lower end of the radius and contains the tendon of the extensor pollicis longus. The *fourth* compartment is broad and shallow and situated to the medial side of the preceding; it contains the tendons of the extensor digitorum communis and extensor indicis proprius. The *fifth* compartment is over the interval between the lower ends of the radius and ulna and contains the tendon of the extensor digiti quinti proprius. The *sixth* compartment corresponds to the groove on the dorsal aspect of the lower end of the ulna between its head and styloid process; it contains the tendon of the extensor carpi ulnaris.

THE FRONT OF THE WRIST AND THE PALM OF THE HAND.

Surface Anatomy.—On the lateral side of the front of the wrist the tubercle of the navicular bone and the ridge on the volar surface of the greater multangular bone can be felt; while on the medial side is the prominence caused by the pisiform bone. In the middle of the palm is a triangular, hollow depression with its apex directed upwards towards the wrist. On the ulnar side of the palm is a rounded eminence called the *hypothenar eminence* produced by the muscles of the little finger and on the radial side is another elevation called the *thenar eminence* formed by the muscles of the thumb. There are three well marked furrows on the skin of the palm: of these the lowest one is more or less transversely situated and corresponds to the metacarpophalangeal joints.

The following structures require to be examined in this dissection :—

Fasciæ	1. Superficial fascia. 2. Palmar aponeurosis.	
Muscles	1. Adductor pollicis brevis. 2. Opponens pollicis. 3. Flexor pollicis brevis. 4. Abductor pollicis.	of thenar eminence.
	5. Palmaris brevis. 6. Abductor digiti quinti. 7. Flexor digiti quinti brevis. 8. Opponens digiti quinti.	of hypo-thenar eminence.
	9. Lumbricales. 10. Interossei.	
Vessels	1. Superficial volar arch with its branches. 2. Deep volar arch with its branches. 3. 4. Arteria princeps pollicis and arteria volaris radialis indicis.	
Nerves	1. 2. Palmar cutaneous branches of the ulnar and median nerves. 3. Terminal part of the volar branch of the lateral antibrachial cutaneous nerve. 4. Ulnar nerve and its branches. 5. Median nerve and its branches.	
Ligaments	1. Volar carpal ligament. 2. Transverse carpal ligament.	

Flexor tendons and their sheaths.

Reflect the skin of the palm by the following incisions :—(1) a vertical incision along the middle line of the palm ; (2) a transverse incision along the roots of the fingers ; (3) from the transverse cut vertical incisions along the middle lines of the front of the digits. In reflecting the skin take care not to injure (*a*) the subcutaneous muscle, palmaris brevis, placed across the upper part of the hypothenar eminence ; (*b*) the superficial transverse fasciculi placed across the palm at the roots of the fingers, and (*c*) the three cutaneous nerves descending from the forearm.

The **Superficial Fascia** of the palm contains granular fat placed between fibrous septa passing between the skin and the subjacent palmar aponeurosis.

The **Palmaris Brevis** (Fig. 118) consists of transversely disposed fibres situated at the upper part of the hypothenar eminence. It arises from the transverse carpal ligament and from the palmar aponeurosis. The fibres are inserted into the skin on the medial border of the palm. The development of the muscle varies; sometimes it is represented by a few scattered fibres. It is supplied by the ulnar nerve.

The *superficial transverse fasciculi* consist of a thin band stretching across the roots of the fingers. It is intimately attached to the skin at the clefts of the fingers.

Cutaneous Nerves of the Palm.—The *palmar cutaneous branch of the ulnar nerve* has been secured where it pierces the deep fascia above the wrist. It supplies the skin on the medial aspect of the palm.

The *palmar cutaneous branch of the median nerve* pierces the deep fascia above the transverse carpal ligament. It descends over the ligament and divides into two branches, a lateral and a medial. The lateral branch supplies the skin over the thenar eminence and communicates with the volar branch of the lateral antibrachial cutaneous nerve. The medial branch supplies the skin of the palm and communicates with the palmar cutaneous branch of the ulnar nerve.

The *terminal part of the volar branch of the lateral antibrachial cutaneous nerve* descends along the lateral part of the palm supplying the skin of the ball of the thumb and communicates with the palmar cutaneous branch of the median nerve and with the superficial branch of the radial nerve.

Remove the superficial fascia and clean the dense palmar aponeurosis underneath.

The **Palmar Aponeurosis** (palmar fascia) is a silvery white membrane consisting of three portions, lateral,

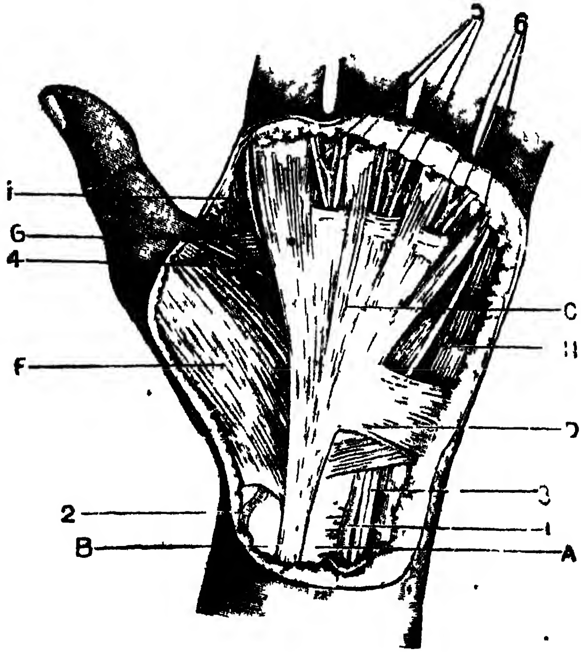


Fig. 113.—Superficial dissection of the palm (Cunningham).

A. Transverse carpal ligament
B. Tendon of palmaris longus.
C. Palmar aponeurosis.
D. Palmaris brevis.
F. Abductor pollicis brevis.
G. Adductor pollicis (transverse portion).
H. Abductor digiti quinti.
I. First dorsal interosseous muscle.

1. Ulnar artery.
2. Superficial volar artery.
3. Ulnar nerve.
4. Proper volar digital branch of median nerve.
5. Proper volar digital branches of median nerve.
6. Proper volar digital branches of ulnar nerve.

central and medial. The *lateral* and *medial portions* are thin and cover the muscles of the thumb and little finger

respectively. The *central portion* is very strong and dense, and occupies the middle of the palm. It has a triangular outline, the apex being directed towards the wrist where it is attached to the transverse carpal ligament and where the expanded tendon of the palmaris longus is blended with it. The base is broad and directed downwards. Near the metacarpophalangeal articulations it divides into four slips for the four fingers. Transverse fibres stretch between these slips at their angles of separation. The digital vessels and nerves and the lumbrical muscles are seen in the intervals between these digital slips. Examine any one of these four digital slips. Each slip will be seen to lie in front of the sheath of the flexor tendons proceeding to the finger and to split into two diverging strips, forming an arch beneath which the flexor tendons proceed downwards to their insertion. The arch is attached to the subjacent sheath of the flexor tendons and higher up to the transverse metacarpal ligament connecting the heads of the metacarpal bones.

Cut through the central part of the palmar aponeurosis near its attachment to the transverse carpal ligament and throw it towards the fingers. Note that from the deep surface of the lateral margins of the central portion of the aponeurosis two septa pass backwards to meet a fascial layer covering the interossei muscles. These two septa divide the palm into three fascial compartments. The lateral one contains the muscles of the thenar eminence and the medial one those of the hypothenar eminence. The central compartment contains the long flexor tendons, the lumbricales, the termination of the median nerve and the superficial volar arch.

Superficial Volar Arch (Superficial palmar arch) (Fig. 108).—The ulnar artery enters the palm by crossing the medial end of the transverse carpal ligament. It continues downwards for a short distance, arches lateral-

wards across the palm and completes the superficial volar arch by anastomosing with the superficial volar artery or with the arteria volaris radialis indicis or with the arteria princeps pollicis. The convexity of the arch is directed downwards towards the fingers. The superficial volar arch is in relation anteriorly with the palmaris brevis and the central portion of the palmar aponeurosis, while posteriorly with the transverse carpal ligament, the flexor digiti quinti brevis, the opponens digiti quinti, the superficial flexor tendons, and the digital branches of the median and ulnar nerves.

The **Branches of the Ulnar Artery,** at this stage, are the deep volar branch, the proper digital branch, and three common digital branches.

The *deep volar branch* passes backwards between the abductor digiti quinti and the flexor digiti quinti brevis and completes the deep volar arch by joining the terminal part of the radial artery. The proper *volar digital branch* arises from the ulnar end of the superficial volar arch. It supplies the medial side of the little finger. The *common volar digital branches* are three in number. They arise from the convexity of the superficial volar arch. They lie in the intervals between the flexor tendons over the digital nerves and are joined by the corresponding volar metacarpal branches of the deep volar arch. Each of these bifurcates opposite the interspace between two contiguous fingers into proper digital branches. These proper digital branches pass along the contiguous sides of the fingers beneath the digital nerves. The two proper digital arteries which run along the sides of a finger anastomose with each other forming an arch near the termination of the last phalanx. From this arch minute twigs are supplied to the subcutaneous tissue of the finger tip and the nail bed. They also communicate by dorsal branches with the dorsal digital arteries.

Ulnar Nerve.—The ulnar nerve enters the palm by crossing the transverse carpal ligament close to the pisiform bone. Here it lies on the medial side of and a little behind the ulnar artery. Immediately below the pisiform bone, it divides into a superficial and a deep branch. The *superficial branch* supplies the palmaris brevis and the skin on the medial side of the palm and ends in two branches, a proper volar digital nerve and a common volar digital nerve. The former supplies the medial side of the little finger; the latter sends a filament to the median nerve; and divides into two proper volar digital nerves which supply the contiguous sides of the little and ring fingers. At the terminal phalanx the digital nerve divides into two branches, of which one supplies the pulp and the other ramifies beneath the nail. The *deep branch* accompanies the deep branch of the ulnar artery, and will be traced at a later stage of the dissection.

The **Median Nerve** enters the palm by passing beneath the transverse carpal ligament. Here it becomes enlarged and flattened and divides into two portions, a lateral and a medial. The *lateral portion* gives off (1) a *muscular branch* which supplies the abductor pollicis brevis, opponens pollicis, and the superficial head of the flexor pollicis brevis; and (2) three *proper volar digital branches*, two of which are distributed to the sides of the thumb and the third to the radial side of the index finger after supplying a twig to the first lumbrical muscle. The *medial portion* gives off (1) two *common volar digital branches*, of which the lateral one supplies a twig to the second lumbrical muscle and divides at the cleft between the fingers into two proper volar digital branches which supply the contiguous sides of the index and middle fingers. The medial one sometimes supplies a twig to the third lumbrical muscle and divides opposite the cleft between the middle and ring fingers to supply the

contiguous sides of those fingers. The proper volar digital nerves are distributed to the fingers in the same manner as those of the ulnar nerve.

The **Transverse Carpal Ligament** (anterior annular ligament) is an exceedingly strong fibrous band which bridges over the concavity in front of the carpus forming a tunnel for the passage of the flexor tendons from the forearm into the palm. Laterally it is attached to the tubercle of the navicular bone and the ridge on the volar surface of the greater multangular bone. Medially it is attached to the pisiform bone and to the tip of the hook of the hamate bone. Above it is continuous with the antibrachial fascia, and below the palmar aponeurosis is attached to it. At the sides it gives origin to most of the muscles of the thenar and hypothenar eminences. The tendon of the palmaris longus passes along its volar surface to be blended with the palmar aponeurosis. The ulnar artery and nerve and the palmar cutaneous branches of the ulnar and median nerves enter the palm by crossing it superficially. The tendon of the flexor carpi radialis pierces it at its lateral attachment and passes through the groove on the volar surface of the greater multangular bone. The tunnel which it forms with the front of the carpus is elliptical in shape with the broad diameter transverse and gives passage to the tendons of the flexor digitorum sublimis, flexor digitorum profundus, and flexor pollicis longus and the median nerve. The *volar carpal ligament* is another band of fascia lying superficial to the transverse carpal ligament and having the same attachments as those of the latter. It binds the ulnar vessels and nerve to the transverse carpal ligament.

Now study the muscles constituting the ball of the thumb and that of the little finger.

Muscles of the Ball of the Thumb.—

The *abductor pollicis brevis* (abductor pollicis) arises

(1) from the transverse carpal ligament, (2) from the tubercle of the navicular bone, and (3) from the ridge of the greater multangular bone. It is inserted into the radial side of the base of the first phalanx of the thumb. It is supplied by the median nerve.

The *opponens pollicis* lies under cover of the preceding muscle. It arises from the transverse carpal ligament and from the ridge on the volar surface of the greater multangular bone. It is inserted into the whole of the radial side of the metacarpal bone of the thumb. It gets its nerve-supply from the median nerve.

The *flexor pollicis brevis* consists of two portions, a superficial and a deep. The *superficial portion* arises from the transverse carpal ligament and from the ridge on the greater multangular bone. It is inserted into the radial side of the base of the first phalanx of the thumb where a sesamoid bone is seen. The *deep portion* arises from the ulnar side of the base of the first metacarpal bone and is inserted into the medial side of the base of the first phalanx of the thumb. The superficial portion is supplied by the median nerve and the deep portion by the deep branch of the ulnar nerve.

The *adductor pollicis* consists of two portions, an oblique and a transverse. The *oblique portion* arises from the volar aspects of the lesser multangular and capitate bones and also from the volar aspects of the bases of the second and third metacarpal bones. The *transverse portion* arises from the lower two-thirds of the volar border of the third metacarpal bone. The two portions are inserted together at the medial side of the base of the first phalanx of the thumb blending with the insertion of the deep portion of the flexor pollicis brevis. Both the portions are supplied by the deep branch of the ulnar nerve.

Muscles of the Ball of the Little Finger.—

The *abductor digiti quinti* (abductor minimi digiti)

arises (1) from the pisiform bone, (2) from the tendon of the flexor carpi ulnaris, and (3) from the transverse carpal ligament. It is inserted into the medial side of the base of the first phalanx of the little finger. It is supplied by the deep branch of the ulnar nerve.

The *flexor digiti quinti brevis* (flexor brevis minimi digiti) arises from the hook of the hamate bone and from the adjacent part of the transverse carpal ligament. It is inserted into the medial side of the base of the first phalanx of the little finger blending with the insertion of the abductor digiti quinti. It is supplied by the deep branch of the ulnar nerve.

The *opponens digiti quinti* (opponens minimi digiti) lies concealed under the two preceding muscles and is exposed on separating them. It arises from the hook of the hamate bone and from the adjacent transverse carpal ligament. It is inserted into the whole length of the medial border of the metacarpal bone of the little finger. It is supplied by the deep branch of the ulnar nerve.

Mucous Sheaths of the flexor tendons on the front of the wrist and palm.—Two mucous sheaths envelope all the flexor tendons as they pass beneath the transverse carpal ligament; of these one surrounds the tendons of the flexores digitorum sublimis and profundus and the other surrounds the tendon of the flexor pollicis longus. They are prolonged upwards into the forearm for nearly an inch above the transverse carpal ligament. The mucous sheath investing the tendon of the flexor pollicis longus follows the tendon as far as its insertion into the last phalanx of the thumb. The other mucous sheath enveloping the tendons of the flexores digitorum terminates near the middle of the metacarpal bones in blind diverticula. But the offshoot for the tendons of the little finger extends as far as its last phalanx. The

mucous sheaths enveloping the digital portions of the flexor tendons of the index, middle and ring fingers extend upwards as far as the junction of the head and body of the corresponding metacarpal bones and hence do not communicate with the large mucous sheath beneath the transverse carpal ligaments.

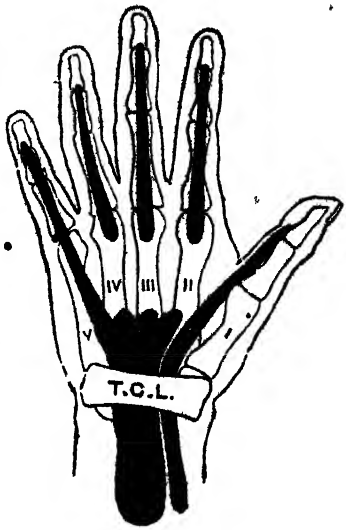


Fig. 114.—Diagram to illustrate the arrangement of the mucous sheaths around the flexor tendons of the hand and wrist (Cunningham). T. C. L. Transverse carpal ligament.

Fibrous and Mucous Sheaths of the flexor tendons of the digits. -Cut vertically through the transverse carpal ligament. Observe that two tendons, one from the flexor digitorum sublimis and the other from the flexor digitorum profundus proceed downwards to each of the four fingers and run along the volar surfaces of their phalanges, while the tendon of the flexor pollicis longus runs lateralwards and downwards along the volar surface of the thumb. From the deep flexor tendons the lumbricales arise. In the digits the flexor tendons are contained in osseo-fibrous canals extending from the metacarpophalangeal articulations to the bases of the last phalanges. The front wall of the canal is formed by a strong fibrous membrane which arches [illegible] the tendons and is attached on either side to the lateral [illegible] of the phalanges

and the volar accessory ligaments of the interphalangeal joints ; while the hind wall is osseous being formed by the

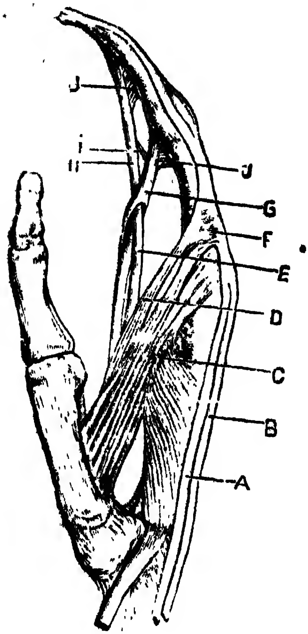


Fig. 115.—Diagram to illustrate the tendons attached to the index finger (Cunningham).

A. Tendon of extensor digitorum communis.

B. Tendon of extensor indicis proprius.

C. First dorsal interosseous muscle.

D. First lumbrical muscle.

E. Flexor digitorum profundus.

F. Expansion of extensor tendon.

G. Flexor digitorum sublimis.

H. Flexor digitorum profundus.

I. J. Vincula tendinæ.

volar surfaces of the phalanges. Opposite the middle of the first and second phalanges the fibrous sheaths are strengthened by a band of transverse fibres called the *digital vaginal ligament*. But opposite the joints the sheaths are thin and are formed by circular and cruciate fibres, called the *annular* and *cruciate ligaments* respectively. Slit open one of the fibrous sheaths along the entire length of the digit and note that the mucous sheath lining the fibrous wall reflected over the enclosed tendons. Raise the flexor tendons from the bones and observe that they are connected to the volar aspects of the phalanges by

folds of the mucous sheath, called the *vincula tendinæ*, which are of two kinds, short and long. The *vincula brevia* are two in number. They are triangular folds which extend from the flexor tendons to the subjacent phalanges just before their insertions. The *vincula longa* are thread-like bands which pass from the flexor tendons on a higher level and connect them to the subjacent phalanges.

Insertion of the flexor tendons into the digits.—The mode of insertion of the tendons of the flexores digitorum sublimis and profundus is next to be examined. The tendon of the flexor digitorum sublimis becomes flattened in front of the first phalanx and then divides into two slips to allow the passage of the tendon of the flexor digitorum profundus through it. The two slips of the superficial tendon reunite to form a grooved surface for the passage onwards of the deep flexor tendon, but divides again to be inserted into the margins of the second phalanx. The tendon of the flexor digitorum profundus passes through the aperture in the tendon of the flexor digitorum sublimis in front of the first phalanx and is inserted into the base of the terminal phalanx.

The tendon of the flexor pollicis longus, on reaching the proximal phalanx of the thumb, enters an osseo-fibrous canal similar to those of the fingers and is inserted into the base of the terminal phalanx.

The **Lumbricales** are four slender, rounded muscles which arise from the tendons of the flexor digitorum profundus in the palm. The *first* and *second* lumbricales arise from the lateral margins of the tendons for the index and middle fingers respectively. The *third* arises from the adjacent margins of the tendons for the middle and ring fingers and the *fourth* from the adjacent margins of those for the ring and little fingers. Each terminates in a slender tendon which passes dorsally along the lateral

aspect of the corresponding metacarpophalangeal articulation to be inserted into the expansion of the extensor tendon on the dorsum of the first phalanx. The two lateral lumbricales are supplied by the digital branches of the median nerve and the two medial ones by the deep branch of the ulnar nerve.

All the flexor tendons should now be divided and reflected downwards. Clean the deep volar arch and trace the deep branch of the ulnar nerve.

Radial Artery in the Palm.—The radial artery enters the palm by passing through the upper part of the first interosseous space. It appears in the palm between the transverse and oblique portions of the adductor pollicis. It then passes medialwards upon the interossei muscles and across the metacarpal bones below their bases. On reaching the base of the fifth metacarpal bone it joins the deep branch of the ulnar artery to complete the **deep volar arch.** This arch lies under cover of the flexor tendons, the lumbricales, and the flexor digiti quinti brevis. The deep branch of the ulnar nerve lies along the arch. The *branches* given off from the radial artery in the palm are :—(1) The *arteria princeps pollicis* which is the first branch of the radial artery in the palm. It runs downwards and lateralwards beneath the oblique portion of the adductor pollicis. Reaching the base of the first phalanx of the thumb it divides into two branches which correspond to the proper volar digital branches of the fingers. These two branches proceed one on either side of the thumb and are distributed like the proper volar digital arteries. (2) The *arteria volaris indicis radialis.* It may have a common origin with the preceding artery. It passes downwards between the first dorsal interosseous muscle and the transverse portion of the adductor pollicis and is distributed to the radial side of the volar aspect of the index finger like the proper volar

digital arteries. At the lower border of the adductor pollicis it sends a communicating branch to the superficial volar arch. (3) The *deep volar arch* (deep palmar arch). It is completed as already stated by the anastomosis of the terminal portion of the radial artery with the deep branch of the ulnar artery. This arch lies on a higher level than the superficial volar arch. The branches given off from the arch are :—(*a*) *volar metacarpal arteries*. These are three in number and arise from the convexity of the arch. They lie on the interosseous muscles as they proceed downwards along the second, third, and fourth interosseous spaces and anastomose with the corresponding common volar digital branches of the superficial volar arch before their bifurcation. (*b*) *Perforating branches*. These are also three in number and pass backwards from the arch through the upper parts of the second, third, and fourth interosseous spaces to anastomose with the dorsal metacarpal arteries. (*c*) *Recurrent branches* which are minute twigs proceeding upwards from the concavity of the arch in front of the carpus to anastomose with the volar carpal branches of the ulnar and radial arteries and form a network called the *volar carpal network*.

The **deep branch of the ulnar nerve** supplies branches to the short muscles of the little finger soon after its origin. It accompanies the deep branch of the ulnar artery and passes between the abductor digiti quinti and the flexor digiti quinti brevis. It then proceeds lateralwards beneath the flexor tendons and along the line of the deep volar arch. Reaching the lateral side of the palm it divides into terminal filaments which supply the first dorsal interosseous muscle, the adductor pollicis, and the deep portion of the flexor pollicis brevis. During its course across the palm it supplies branches to all the other interossei and the two medial lumbricales.

The dissector should now examine the transverse metacarpal ligament as it requires to be divided to display the interossei fully.

The *transverse metacarpal ligament* is a strong band of fibres placed transversely across the volar aspects of the heads of the medial four metacarpal bones. It is attached to the accessory volar ligaments of the metacarpo-phalangeal joints.

Divide the transverse portion of the adductor pollicis at its origin and reflect it towards the insertion. Divide the transverse metacarpal ligament in the spaces between the fingers.

The **Interossei Muscles** fill up the intervals between the metacarpal bones. They are divided into two groups, a dorsal and a volar.

The **Dorsal Interossei** are four in number and are better seen from the dorsal aspect of the hand. Each muscle arises by two heads from the opposed surfaces of two contiguous metacarpal bones and the fibres end in a slender tendon. The *first dorsal interosseous muscle* (abductor indicis) (Fig. 115) is inserted into the radial side of the base of the first phalanx of the index finger and into the expansion of the extensor tendon lying on its dorsum. The *second* and *third dorsal interossei* are inserted into the radial and ulnar sides respectively of the base of the first phalanx of the middle finger and into the expansion of the extensor tendon. The *fourth dorsal interosseous* is inserted into the ulnar side of the base of the first phalanx of the ring finger and into the expansion of the extensor tendon on its dorsum.

The **Volar Interossei** (palmar interossei), three in number, are smaller than the dorsal interossei and are seen only from the volar aspect of the hand. Each muscle arises from a single metacarpal bone. Thus the *first* arises from the ulnar side of the second metacarpal bone

and is inserted into the same side of the base of the first phalanx of the index finger and into the expansion of the extensor tendon. The *second* and *third* take their origin from the radial sides of the fourth and fifth metacarpal bones respectively. They are inserted into the same sides of the base of the first phalanges of the ring and little fingers respectively and into the expansions of the extensor tendons lying on their dorsal surfaces. All the interosseous muscles are supplied by the deep branch of the ulnar nerve.

The course of the tendon of the flexor carpi radialis along the groove on the volar surface of the greater multangular bone and its insertion into the volar aspects of the bases of the second and third metacarpal bones should now be verified.

Cubital Articulation or Elbow Joint.—The elbow-joint includes three articulations, viz., (1) the humero-ulnar, (2) the humero-radial, and (3) the proximal radio-ulnar. The bony surfaces entering into the formation of the humero-ulnar articulation are the trochlea of the humerus and the semilunar notch of the ulna; those of the humero-radial articulation are the capitulum of the humerus and the fovea on the head of the radius; and those of the proximal radio-ulnar articulation are the medial part of the circumference of the head of the radius and the radial notch of the ulna. Of these three, the humero-ulnar and humero-radial articulations will be considered together. They form a ginglymus or hinge-joint. The ligaments are :—

(1) *Articular capsule.*—Its anterior part is attached above to the front aspects of the epicondyles of the humerus on either side and to the upper margins of the coronoid and radial fossæ in the middle. Below it is attached to the anterior and medial margins of the coronoid process and to the annular ligament. The posterior

part of the capsule is very thin and loose and is attached above to the posterior surface of the humerus, above the olecranon fossa and behind the capitellum. Below it is attached to the anterior margin of the superior surface of the olecranon and to its lateral border. It is also attached to the annular ligament.

(2) The *ulnar collateral ligament* (internal lateral ligament) consists of three portions, an anterior, a posterior, and an intermediate. The *anterior portion* extends from the front of the medial epicondyle of the humerus to the medial margin of the coronoid process. The *posterior portion* is attached above to the lower and back part of the medial epicondyle of the humerus and below to the medial margin of the olecranon. The *intermediate portion* consists of transverse fibres passing from the medial margin of the olecranon to the medial margin of the coronoid process.

(3) The *radial collateral ligament* (external lateral ligament) is attached above to the lower aspect of the lateral epicondyle of the humerus and below to the annular ligament and to the lateral margin of the olecranon.

The *synovial stratum* lines the deep surface of the entire capsule and is prolonged into the proximal radio-ulnar articulation. Pads of fat are seen between the synovial stratum and the capsule ; one above the olecranon fossa ; the second above the coronoid fossa ; and the third over the radial fossa.

The **Proximal Radioulnar Articulation** is a pivot-joint ; the head of the radius being the pivot and the ring is formed by the radial notch of the ulna and the annular ligament. The *annular ligament* forms four-fifths of the ring and the remaining fifth is formed by the radial notch of the ulna. It is a fibrous band which encircles the head of the radius and is attached to the anterior and posterior margins of the radial notch. To its upper border

are attached the articular capsule and the radial collateral ligament of the elbow-joint. Its lower border is loosely attached to the neck of the radius below. Its deep surface is lined by a continuation of the synovial stratum of the elbow-joint. Its superficial surface gives origin to the supinator muscle.

The **Distal Radio-ulnar Articulation** is a pivot-joint. The bony parts entering into the formation of the joint are the head of the ulna and the ulnar notch of the radius. The parts are held together by : (1) The *articular capsule* which is loose ; it is attached around the head of the ulna and to the volar and dorsal margins of the ulnar notch of the radius. It is also attached to the volar and dorsal margins of the articular disc. A pouch of the capsule lined by synovial stratum is prolonged upwards between the two bones and is called the *recessus sacciformis.* (2) The *articular disc* (interarticular fibro-cartilage) is triangular in shape and is placed beneath the head of the ulna. Its apex is attached to a depression at the root of the styloid process of the ulna and its base is attached to the prominent margin at the lower end of the radius which lies between the ulnar notch of the radius and its carpal articular surface. It is thus interposed between the distal radioulnar joint and the radiocarpal joint. The *synovial stratum* of the joint is very loose. It extends between the head of the ulna and the articular disc and is prolonged upwards for some distance between the radius and ulna.

There are two ligaments, viz., the interosseous membrane and the oblique cord which bind together the bodies of the radius and ulna.

The *antibrachial interosseous membrane* extends from the interosseous crest of the radius to that of the ulna. Its fibres are mostly directed from the radius downwards and medialwards to the ulna. Above it extends up to

a point about one inch below the tuberosity of the radius and the interval between its upper margin and the oblique cord gives passage to the dorsal interosseous vessels. Below it is continuous with the articular capsule of the distal radioulnar joint. At about the junction of its upper three-fourths with the lower fourth it is pierced by the volar interosseous vessels. Its volar and dorsal surfaces give origin to some of the muscles of the forearm which have been already referred to. The volar interosseous vessels and nerve run along its volar surface. The *oblique cord* (oblique ligament) is a fibrous band which extends obliquely from the tubercle at the base of the coronoid process downwards and lateralwards to the radius immediately below its tuberosity.

The **Radiocarpal Articulation** or **Wrist Joint** is a condyloid articulation; the concave articular surface being formed by the inferior surface of the lower end of the radius and the inferior surface of the articular disc, while the ovoid convex articular surface is formed by the superior surfaces of the navicular, lunate, and triquetral bones. The ligaments belonging to this articulation are :

(1) The *articular capsule* is attached above to the volar and dorsal margins of the articular surface of the radius and of the articular disc. Below it is attached to the volar and dorsal aspects of the first three bones of the carpus.

(2) The *volar radiocarpal ligament* is attached above to the anterior margin of the lower end of the radius and its styloid process. It is also attached to the anterior aspect of the head of the ulna. Below it is attached to the volar surfaces of the navicular, lunate, and triquetral bones: some fibres are prolonged to the capitate bone.

(3) The *dorsal radiocarpal ligament* extends from the posterior border of the lower end of the radius to the dorsal surfaces of the navicular, lunate, and triquetral bones.

(4) The *ulnar collateral ligament* (internal lateral ligament) passes from the tip of the styloid process of the ulna to the triquetral and pisiform bones.

(5) The *radial collateral ligament* (external lateral ligament) stretches from the tip of the styloid process of the radius to the lateral side of the navicular bone.

Open the radiocarpal joint and examine the articular surfaces. The synovial stratum lines the articular capsule and the articular surfaces. Rarely it is continuous with the synovial stratum of the distal radio-ulnar articulation.

Intercarpal Articulations. These include (I) articulations between the contiguous bones of the proximal row of the carpus; (II) the midcarpal articulation between the proximal and distal rows of the carpus; and (III) those between the contiguous bones of the distal row of the carpus.

(I). *Articulations between the bones of the proximal row.* The bones of the proximal row are held together by *volar ligaments* which connect the volar surface of the lunate with that of the navicular bone on the lateral side and of the triquetral bone medially. The *dorsal ligaments* connect the dorsal surfaces of the same three bones in a similar manner. The *interosseous ligaments* are two in number and are interposed between the contiguous bones. One connects the lunate and navicular bones and the other the lunate and triquetral bones. They fill up the gaps between the proximal articular surfaces of these bones. The ligaments connecting the pisiform bone are :—(1) The *articular capsule* which surrounds the articular surface of the pisiform bone and that on the volar surface of the triquetral bone. It is lined by a separate synovial stratum. (2) The *pisohamate ligament* connects the pisiform with the hamate bone. (3) The *pisometacarpal ligament* connects the pisiform bone with the base of the fifth metacarpal bone.

II. The *midcarpal articulation* is formed by the first three carpal bones of the proximal row above and all

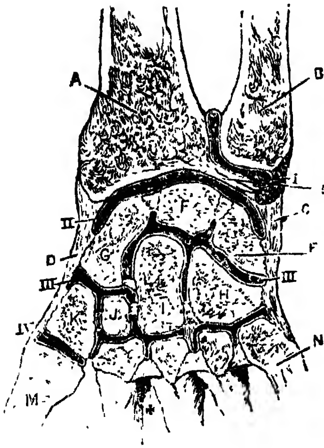


Fig. 116.—Vertical section of the wrist showing the synovial strata.

A. Radius.
B. Ulna.
C. Ulnar collateral ligament.
D. Radial collateral ligament.
E. Triquetral bone.
F. Lunate bone.
G. Navicular bone.
H. Hamate bone.
I. Capitate bone.
J. Lesser multangular bone.
K. Greater multangular bone.
L. Articular disc.
M. Metacarpal bone of thumb.
N. Metacarpal bone of little finger.
I, II, III, IV.—Synovial strata.

the bones of the distal row below. The ligaments belonging to this articulation are :—(1) The *volar ligament* which connects the volar surfaces of the bones entering into the formation of the joint. A band radiates from the volar surface of the head of the capitate bone to the neighbouring bones and is called the *ligamentum carpi radiatum*. (2) The *dorsal ligaments* connect the dorsal surfaces of the bones entering into the formation of the joint. (3) The *radial collateral ligament* (external lateral ligament) connects the navicular and greater multangular bones laterally. (4) The *ulnar collateral ligament* (internal lateral ligament) passes from the triquetral to the hamate bone medially.

The midcarpal joint should now be opened and the articular surfaces examined.

III. *Articulations between the bones of the distal row.*—These articulations have three volar, three dorsal and

three interosseous ligaments between the four bones of this row.

The *synovial stratum of the midcarpal joint* extends proximally as two pouches between the contiguous sides of the navicular, lunate, and triquetral bones. Distally the stratum is prolonged between the four bones of the distal row as three pouches. Of these the prolongation between the greater and lesser multangular bones and that between the lesser multangular and hamate bones are usually continuous with the synovial stratum of the carpometacarpal joints.

Intermetacarpal Articulations.—The metacarpal bones of the four fingers are connected with each other by volar, dorsal and interosseous ligaments at their bases. The *transverse metacarpal ligament* also binds the heads of these bones and has been already examined (p. 606).

Carpometacarpal Joints.—

(A) *Carpometacarpal articulation of the thumb.*—The metacarpal bone of the thumb articulates by its base with the greater multangular bone. The articular surfaces are saddle-shaped. The joint is provided with an *articular capsule* lined by a separate synovial stratum.

(B) *Articulations between the carpus and the metacarpal bones of the four fingers.*—The ligaments of these joints are :—(1) One volar ligament along the volar aspect of each of these metacarpal bones. (2) Two dorsal ligaments for each of these metacarpal bones except the fifth. (3) The interosseous ligament which extends from the contiguous inferior angles of the capitate and hamate bones to the medial side of the base of the third metacarpal bone. The synovial stratum is usually continuous proximally with that of the midcarpal joint.

Metacarpophalangeal Articulations.—These are four condyloid articulations between the head of the metacarpal bone and the base of the phalanx of each digit.

The ligaments are :—(1) Accessory volar ligaments (anterior ligaments) which are strong bands placed along the volar aspects of the articulations. They are firmly attached to the bases of the phalanges and loosely to the heads of the metacarpal bones. They are continuous on either side with the collateral ligaments. (2) The collateral ligaments (lateral ligaments) extend along the sides of the joints ; from the posterior tubercles and the adjacent depressions on the heads of the metacarpal bones to the sides of the bases of the proximal phalanges. They are continuous in front with the accessory volar ligaments.

Digital Articulations.—These are hinge-joints. Each joint is provided with an accessory volar and two collateral ligaments which are arranged like those of the metacarpo-phalangeal articulations.

THE INFERIOR EXTREMITY.

THE GLUTEAL REGION.

Devote two days to the dissection of this region. The subject must be placed with its face downwards and blocks are to be put beneath the chest and pelvis.

Surface Anatomy.—Before commencing the dissection of this region the student should recognise the following bony landmarks :—(1) the crest of the ilium, terminating anteriorly in (2) the anterior superior iliac spine, and posteriorly in (3) the posterior superior iliac spine ; (4) the back of the sacrum and coccyx which can be felt along the middle line ; (5) the prominence caused by the ischial tuberosity ; and (6) the greater trochanter of the femur. Observe the prominence of the nates caused by

the glutæus maximus and the transverse groove, called the *gluteal sulcus,* which corresponds approximately with the lower border of the glutæus maximus.

Reflect the skin laterally by the following *incisions* :— (1) A curved incision from the tip of the coccyx along the posterior superior iliac spine and the crest of the ilium. This is to be done in conjunction with the dissector of the superior extremity (p. 519). (2) From the tip of the coccyx downwards and lateralwards over the back of the thigh (Fig. 52).

The following structures will be displayed during the dissection of this region :—

Fasciæ	Superficial. Deep.
Muscles	1. 2. 3. Glutæi maximus, medius, and minimus. 4. Piriformis. 5. 6. Gemelli superior and inferior. 7. Obturator internus. 8. Quadratus femoris. 9. Obturator externus. 10. Part of the adductor magnus. 11. 12. 13. Origins of the hamstring muscles.
Vessels	1. 2. Superior and inferior gluteal vessels. 3. Internal pudendal vessels. 4. Crucial anastomosis.
Nerves	1. Cutaneous. 2. Sciatic. 3. 4. Superior and inferior gluteal. 5. Posterior femoral cutaneous. 6. Pudendal. 7. 8. Nerves to obturator internus and quadratus femoris.

The **Superficial Fascia** in the gluteal region is more fatty than in any other part of the body.

The **Cutaneous Nerves** are to be searched for ramifying in the superficial fascia. These are :—(1) The *lateral cutaneous branch of the last thoracic nerve.* (p. 21). It crosses the iliac crest about two inches behind the anterior superior iliac spine and descends in the gluteal region

supplying the skin as low down as the greater trochanter. (2) The *lateral cutaneous branch of the iliohypogastric*

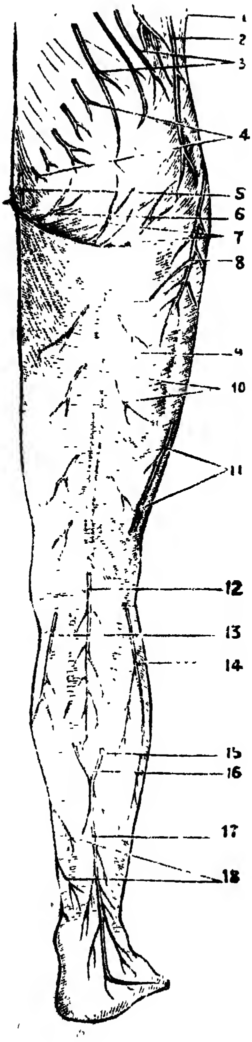


Fig. 117.—Cutaneous nerves of the inferior extremity—posterior view (from Buchanan).

1. **Lateral cutaneous branch of iliohypogastric nerve.**
2. **Lateral cutaneous branch of 12th thoracic nerve.**
3. **Lateral branches of the posterior divisions of 1st, 2nd, and 3rd lumbar nerves.**
4. **Lateral branches of posterior divisions of 1st, 2nd, and 3rd sacral nerves.**
5. **Coccygeal nerve.**
6. **Perforating cutaneous nerve.**
7. **Gluteal branches of posterior femoral cutaneous nerve.**
8. **Posterior branch of lateral femoral cutaneous nerve.**
9. **Posterior femoral cutaneous nerve.**
10. **Branches to back of thigh from the above nerve.**
11. **Lateral femoral cutaneous nerve**
12. **Posterior femoral cutaneous nerve.**
13. **Posterior branch of medial femoral cutaneous nerve.**
14. **Lateral sural cutaneous nerve.**
15. **Peroneal anastomotic nerve.**
16. **Medial sural cutaneous nerve.**
17. **Sural nerve.**
18. **Branches of the saphenous nerve.**

nerve (p. 21). It crosses the iliac crest behind the preceding and supplies the skin above the greater trochanter. (3) The lateral branches of the posterior divisions of the *first, second,* and *third lumbar nerves* (p. 264). These cross the back part of the iliac crest and pass downwards and forwards; some twigs reach as far as the greater trochanter. (4) Three cutaneous twigs from the lateral branches of the posterior divisions of the *upper three sacral nerves*. The lateral branches of the posterior divisions of the upper three sacral nerves form a looped arrangement over the dorsum of the sacrum (p. 264). From these loops three twigs are given off which pierce the glutæus maximus near its origin from the sacrotuberous ligament and supply the skin over the back part of the buttock. (5) The *perforating cutaneous branch of the second and third sacral nerves*. It turns round the lower border of the glutæus maximus between the coccyx and ischial tuberosity. (6) The *gluteal branches of the posterior femoral cutaneous nerve*. These are three or four twigs which turn round the lower border of the glutæus maximus lateral to the ischial tuberosity and ascend to supply the skin of the lower part of the gluteal region. (7) A few *twigs from the lateral femoral cutaneous nerve*. These pass backwards to supply the skin of the front part of the gluteal region.

Remove the superficial fascia and clean the surface of the deep fascia underneath.

The **Deep Fascia** of the gluteal region is attached above to the iliac crest and behind to the dorsum of the sacrum and coccyx. If traced downwards from the iliac crest it is seen to cover the glutæus medius and at the upper border of the glutæus maximus to split into two layers which enclose the latter muscle. At the lower border of the glutæus maximus the two layers reunite and become continuous with the deep fascia of the thigh.

Reflect the deep fascia from the surface of the glutæus maximus muscle. In cleaning the muscle carry the edge of the knife in the direction of the muscle fibres.

The **Glutæus Maximus** arises (1) from the posterior gluteal line, and the narrow rough surface of bone, including the outer lip of the iliac crestlying behind it; (2) from the posterior surface of the lower part of the side of the sacrum; (3) from the posterior surface of the upper part of the side of the coccyx; (4) from the aponeurosis of the sacrospinalis; and (5) from the sacrotuberous ligament. The muscle is made up of coarse fasciculi which pass downwards, lateralwards and forwards. All the fibres of the upper half of the muscle together with the superficial fibres of the lower half are inserted into the fascia lata of the thigh. The deep fibres of the lower half of the muscle are inserted into the gluteal tuberosity of the femur. The muscle is supplied by the inferior gluteal nerve which enters its deep surface.

Reflect the glutæus maximus by dividing it at its origin. As the muscle is thrown downwards and lateralwards the gluteal vessels and the branches of the inferior gluteal nerve will be seen to enter the deep surface of the muscle; some of these are to be divided and others pulled out of the muscle so as to facilitate its reflection towards the insertion.

Mucous bursæ under cover of the glutæus maximus.—Three mucous bursæ are usually found under cover of this muscle; one is situated between it and the greater trochanter of the femur; the second separates it from the tuberosity of the ischium; and the third is placed between the tendon of vastus lateralis and the aponeurotic insertion of the muscle into the gluteal tuberosity of the femur.

The muscles exposed on reflecting the glutæus maximus should now be studied.

Piriformis.—Its origin from the pelvic cavity has been

described (p. 128). It comes out of the pelvis through the greater sciatic foramen and passes downwards,

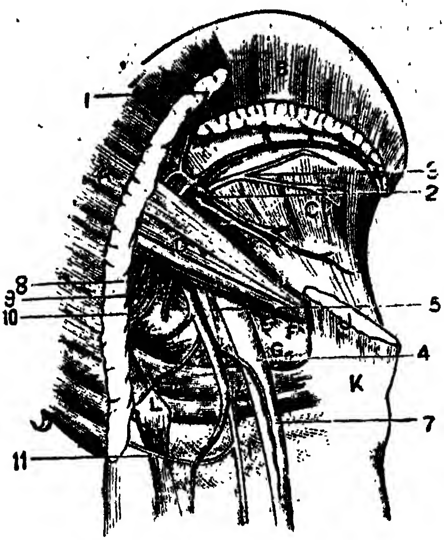


Fig. 118.—Dissection of the gluteal region.

A. Glutæus maximus (cut).
B. Glutæus medius (cut).
C. Glutæus minimus.
D. Piriformis.
E. Gemellus superior.
F. Obturator internus.
G. Gemellus inferior.
H. Quadratus femoris.
I. Adductor magnus.
J. Insertion of glutæus medius.
K. Greater trochanter.
L. Ischial tuberosity.
M. Tendon common to biceps femoris and semitendinosus.

1. Superficial part of superior gluteal artery.
2. Lower branch of the deep part of superior gluteal artery.
3. Superior gluteal nerve.
4. Sciatic nerve.
5. Posterior femoral cutaneous nerve.
7. Arteria comitans nervi ischiadici.
8. Pudendal nerve.
9. Internal pudendal artery.
10. Nerve to obturator internus.
11. Long perineal branch of posterior femoral cutaneous nerve.

lateralwards and forwards to be inserted by a tendon into a rough impression at the upper border of the greater trochanter.

The **Gemellus Superior** is a small muscle which arises from the outer surface of the spine of the ischium and is blended with the upper border of the tendon of the obturator internus with which it is inserted into the medial surface of the greater trochanter. It is supplied by the nerve which supplies the obturator internus muscle.

Obturator Internus.—Its origin from the pelvic cavity has been described (p. 128). Its tendon issues out of the lesser sciatic foramen, becomes blended with the gemellus superior above and the gemellus inferior below, and is inserted into the medial aspect of the greater trochanter in front of the insertion of the piriformis. This muscle is supplied by a special nerve from the sacral plexus.

The **Gemellus Inferior** arises from the upper part of the tuberosity of the ischium below the groove for the tendon of the obturator internus. It is blended with the lower border of the tendon of the obturator internus with which it is inserted. It is supplied by a twig from the nerve which goes to supply the quadratus femoris under cover of these muscles.

The **Quadratus Femoris** is a flat quadrilateral muscle which lies below the preceding. It arises from the lateral margin of the tuberosity of the ischium and passes lateralwards to be inserted into the upper part of the linea quadrata of the femur. It is supplied by a special nerve from the sacral plexus which enters its deep surface.

The **Glutæus Medius** arises (1) from the outer surface of the ilium between the anterior and posterior gluteal lines, and (2) from the deep fascia covering it. The fibres converge to a tendon which is inserted into the oblique ridge on the lateral surface of the greater trochanter. Its tendon is separated from the greater trochanter above the oblique ridge by a mucous bursa. It is supplied by the superior gluteal nerve.

The glutæus maximus also covers the tendon of the

obturator externus, the upper part of the adductor magnus, and the origins of the hamstring muscles. These will be studied later on.

The student should now dissect the vessels and nerves which emerge from the pelvis through the greater sciatic foramen and lie below the level of the piriformis. Clean them properly and study them in succession.

Inferior Gluteal Artery (sciatic artery).—Its origin from the hypogastric artery has been mentioned (p. 119). Issuing out of the pelvic cavity it passes with the sciatic nerve under cover of the glutæus maximus and is continued to the back of the thigh in company with the posterior femoral cutaneous nerve. It gives off the following branches:—(1) The *muscular branches* which supply the glutæus maximus (by entering its deep surface) and the neighbouring muscles. (2) The *coccygeal branches* which pass medialwards, perforate the sacrotuberous ligament and supply the glutæus maximus and the skin over the coccyx. (3) The *arteria comitans nervi ischiadici* is a long slender artery. It lies at first on the surface of the sciatic nerve and then pierces it to supply its substance. (4) The *anastomotic branch* descends to form the upper limb of the *crucial anastomosis* in which the medial and lateral femoral circumflex arteries and the superior perforating artery take part. (5) The *cutaneous branches* supply the skin of the buttock and upper part of the back of the thigh.

Internal Pudendal Artery.—Its origin inside the pelvic cavity has been described (p. 119). It issues out of the pelvis through the greater sciatic foramen, crosses the outer surface of the ischial spine and re-enters the pelvis through the lesser sciatic foramen. It is accompanied by venæ comites.

The **Sciatic Nerve** (greater sciatic nerve) is the largest nerve in the whole body. Its origin from the sacral

plexus has been described (p. 126). It issues out of the pelvic cavity below the piriformis and descends to the thigh along the interval between the tuberosity of the ischium and the greater trochanter of the femur. In its course it crosses the gemelli, the obturator internus, and the quadratus femoris. It is flattened just after its exit and becomes rounded lower down. The arteria comitans nervi ischiadici lies on its surface. Usually it gives off no branch in the gluteal region.

Posterior Femoral Cutaneous Nerve (small sciatic nerve). Its origin from the sacral plexus has been described (p. 126). It issues out of the pelvis below the piriformis and accompanies the inferior gluteal nerve under cover of the glutæus maximus. It then emerges from under cover of the lower border of the muscle and runs downwards on the back of the thigh being covered by the deep fascia only. Its further course will be subsequently traced. Its branches are all cutaneous. These are :– (1) The *gluteal branches* which turn upwards round the lower border of the glutæus maximus and have already been examined. (2) The *perineal branches* supply the skin of the upper and medial aspects of the thigh and of the perineum. One of these branches is longer than the others and is called the *long perineal branch.* It passes medialwards below the tuberosity of the ischium towards the perineum. Its course and distribution in the perineum have been described (p. 6). (3) The *cutaneous branches* for the thigh supply the medial and back parts of the thigh.

Pudendal Nerve.—Its origin from the pudendal plexus has been described (p. 127). It issues out of the pelvis below the piriformis and, crossing the outer surface of the ischial spine medial to the internal pudendal vessels, re-enters the pelvis through the lesser sciatic foramen and becomes distributed in the perineum. (p. 4).

Inferior Gluteal Nerve.—Its origin from the sacral plexus has been described (p. 126). It breaks up into many branches which enter the deep surface of the glutæus maximus to supply it.

Nerve to the Obturator Internus.—Its origin from the sacral plexus has been described. It crosses the ischial spine lateral to the internal pudendal vessels and supplies a twig to the gemellus superior. It re-enters the pelvis through the lesser sciatic foramen and enters the pelvic surface of the obturator internus to supply it.

Divide the obturator internus and gemelli and reflect them on either side. Note the terminal branches of the medial femoral circumflex artery. The *deep branch* ascends towards the trochanteric fossa and the *superficial branch* passes between the adductor magnus and quadratus femoris to join the crucial anastomosis.

Nerve to the Quadratus Femoris.—Its origin from the sacral plexus has been described. Emerging from the greater sciatic foramen it passes downwards and, crossing the superior ramus of the ischium under cover of the sciatic nerve, the gemellus superior, the obturator internus and the gemellus inferior, terminates by entering the deep surface of the quadratus femoris. It gives a twig to the gemellus inferior which enters the deep surface of the muscle, and an *articular twig* to the hip-joint which enters the back part of the articular capsule.

Obturator Externus.—The tendon of this muscle can be seen by separating the contiguous margins of the gemellus inferior and the quadratus femoris when the former muscle is in tact. It is inserted into the trochanteric fossa of the femur. The origin of the muscle will be studied later on.

Now study the structures which lie above the level of the piriformis. These are :—the superior gluteal vessels,

the superior gluteal nerve, the glutæus medius (already described) and the glutæus minimus.

Divide the glutæus medius near its insertion and reflect it upwards.

Superior Gluteal Artery.—Its origin from the hypogastric artery has been described (p. 122). It issues out of the pelvis through the greater sciatic foramen above the piriformis and divides into a superficial and a deep branch. The *superficial branch* divides into several branches which enter the deep surface of the glutæus maximus. These have been examined while the glutæus maximus was reflected. The *deep branch* divides into a superior and an inferior division. The superior division courses forwards towards the anterior superior iliac spine by crossing the upper limit of the glutæus minimus. It anastomoses with the deep circumflex iliac artery and with the ascending branch of the lateral femoral circumflex artery. The inferior division crosses the surface of the glutæus minimus obliquely in its course to the greater trochanter and supplies the glutæus medius and minimus; some twigs pierce the latter muscle to supply the hip-joint. The venæ comitantes open into the hypogastric vein.

Superior Gluteal Nerve.—Its origin from the sacral plexus has been described (p. 126). It issues out of the pelvis above the piriformis accompanied by the superior gluteal vessels. It divides into a superior and an inferior branch. The *superior branch* accompanies the superior division of the deep branch of the superior gluteal artery and supplies the glutæus minimus. The *inferior branch* accompanies the inferior division of the deep branch of the superior gluteal artery and supplies the glutæus medius and minimus and ends in the tensor fasciæ latæ.

Most of the structures covered by the glutæus maximus have been examined and the student is now in a position

to enumerate them. These are :—(I) *Muscles*.—1. Glutæus medius. 2. Piriformis. 3, 4, 5. Obturator internus and two gemelli. 6. Quadratus femoris. 7. Tendon of obturator externus. 8. Upper part of adductor magnus. 9, 10, 11. Origin of three hamstring muscles from ischial tuberosity. (II) *Vessels*.—1, 2. Superior and inferior gluteal vessels. 3. Internal pudendal vessels. 4. Crucial anastomosis. (III) *Nerves*. 1, 2. Superior and inferior gluteal nerves. 3. Sciatic nerve. 4. Posterior femoral cutaneous nerve. 5. Pudendal nerve. 6. Nerve to obturator internus. 7. Nerve to quadratus femoris. (IV) *Bones*.—1. Ilium. 2. Sacrum and coccyx. 3. Tuberosity of ischium. 4. Greater trochanter of the femur. (V) *Ligament*.—Sacrotuberous ligament. (VI) *Bursæ*.—Three mucous bursæ.

Reflect the glutæus minimus by cutting close to its origin and throw it downwards. Note that it is firmly adherent to the capsule of the hip-joint. On reflecting the muscle the reflected tendon of the rectus femoris, attached to the dorsum ilii above the margin of the acetabulum, is seen. A mucous bursa interposed between the tendon of the glutæus minimus and the greater trochanter is also exposed.

THE POPLITEAL FOSSA.

The dissection of the popliteal fossa should be finished in one day. Put a block under the knee during the dissection of this space.

Surface Anatomy.—Note the prominences of the medial and lateral condyles of the femur. Feel the adductor tubercle at the junction of the medial condyle with its epicondylar ridge. The medial and lateral condyles of the tibia and the head of the fibula can be palpated.

On the lateral side the tendon of the biceps femoris and on the medial side the tendons of the semitendinosus and semimembranosus can be felt above the knee. Below the knee the prominence caused by the two heads of the gastrocnemius is to be noted.

Reflect the skin by the following *incisions* (Fig. 52) :- (1) a vertical incision about eight inches in length along the middle line of the back of the limb, half of it lying above and half below the bend of the knee ; (2) two transverse incisions passing from the medial to the lateral side of the limb, one at the upper and the other at the lower end of the vertical incision.

The following structures will be displayed in this dissection : —

Fasciæ	1. Superficial. 2. Deep.
Muscles	1. Biceps femoris. 2. Semitendinosus. 3. Semimembranosus. 4. Plantaris. 5. Gastrocnemius. 6. Popliteus.
Vessels	1. Popliteal artery and its branches. 2. Popliteal vein and its tributaries
Nerves	1. Posterior femoral cutaneous nerve. 2. Popliteal nerve and its branches. 3. Common peroneal nerve and its branches. 4. Geniculate branch of the obturator nerve.

Lymph glands.

Superficial Fascia. —It is a part of the superficial fascia of the thigh and leg. Search for the terminal part of the posterior femoral cutaneous nerve and the small saphenous vein ; the former descends and the latter ascends along the middle line of the space.

The *terminal part of the posterior femoral cutaneous nerve* pierces the popliteal fascia at about its middle. It descends along the middle line of the leg and terminates about midway between the knee and ankle. The *small*

saphenous vein ascends along the middle line of the back of the leg and at the lower part of the popliteal fossa pierces the deep fascia. Its termination in the popliteal vein will be seen during the deep dissection of the fossa.

The **Deep Fascia** over the popliteal fossa is a part of the deep fascia of the thigh. Below it is continuous with the deep fascia of the leg.

Reflect the deep fascia by the same incisions as those for the skin.

Boundaries.—The popliteal fossa is lozenge-shaped and is bounded above and laterally by the tendon of the biceps femoris; above and medially by the semimembranosus and semitendinosus; below and medially by the medial head of the gastrocnemius; below and laterally by the lateral head of the gastrocnemius and the plantaris. The **floor** is formed from above downwards by the popliteal surface of the femur, the oblique popliteal ligament of the knee-joint, and the fascia covering the popliteus muscle at the back part of the upper end of the tibia.

The **contents** of the entire space should now be dissected by removing the fat and cleaning the structures carefully. These are :—the popliteal artery with its branches, the popliteal vein with its tributaries, the tibial and common peroneal nerves with their branches given off in the popliteal fossa, the geniculate branch of the obturator nerve lying along the medial side of the popliteal artery, and a few lymph glands along the course of the blood vessels.

The **Tibial Nerve** (internal popliteal nerve) is the larger of the two terminal branches of the sciatic nerve. It runs downwards along the middle line of the fossa and is the most superficially placed of all the important structures contained in the space. Emerging from under cover of the biceps femoris it lies at first lateral to the popliteal vessels in the upper third of the popliteal fossa.

In the middle third of the fossa it lies behind the vessels and in the lower third, runs along their medial side. The

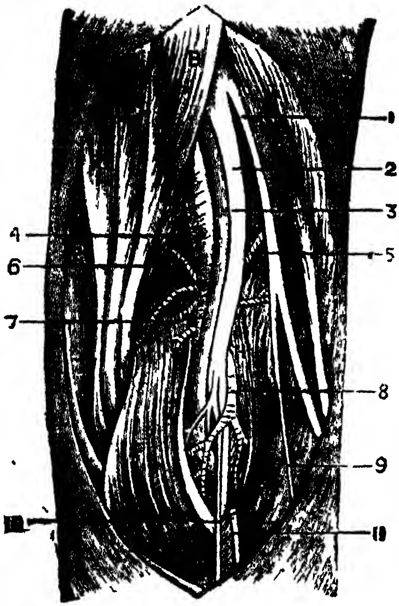


Fig. 119.—Dissection of the popliteal fossa.

A. Biceps femoris
B Semitendinosus.
C. Semimembranosus.
D Gracilis.
E. Sartorius.
F. Medial head of gastrocnemius.
G. Lateral head of gastrocnemius
H. Plantaris.
1. Common peroneal nerve.
2. Tibial nerve.
3. Popliteal vein.
4. Popliteal artery.
5 Medial superior genicular artery.
6. Lateral superior genicular artery.
7. Superior muscular branch.
8. Sural branch.
9. Peroneal anastomotic nerve
10. Medial sural cutaneous nerve.
11. Small saphenous vein.

portion of the nerve in the popliteal fossa extends up to the lower border of the popliteus muscle.

Branches :— (1) The *medial sural cutaneous nerve* (nervus communicans tibialis). It arises opposite the middle of the fossa and runs in the groove between the two heads of the gastrocnemius in company with the small saphenous vein. It unites with the peroneal anastomotic branch at the back of the leg and forms the sural nerve which will be traced later on. (2) *Muscular branches.* These supply both heads of the gastrocnemius, plantaris, soleus and popliteus. The branch to the popliteus descends along the fascia covering its superficial surface and turns round the lower border of the

muscle to gain its deep surface. (3) The *articular branches* are three in number. One of these accompanies the middle genicular artery and enters the middle of the oblique popliteal ligament. The other two accompany the superior and inferior medial genicular arteries.

The **Common Peroneal Nerve** (external popliteal nerve) is smaller than the tibial nerve. It passes downwards along the medial margin of the biceps femoris, then lies between the tendon of that muscle and the lateral head of the gastrocnemius and finally winds round the neck of the fibula to divide into two terminal branches, the superficial and deep peroneal nerves. Its branches are articular and cutaneous. Of the *articular branches* two accompany the superior and inferior lateral genicular branches of the popliteal artery. The third articular branch is given off near the termination of the nerve and hence is not found in the popliteal fossa. The cutaneous branches are two in number. (1) The *lateral sural cutaneous nerve* supplies the skin over the lateral part of the back of the calf. (2) The *peroneal anastomotic nerve* (nervus communicans fibularis) either arises separately or in common with the preceding nerve. It crosses the lateral head of the gastrocnemius to join the medial sural cutaneous nerve and form the sural nerve which will be subsequently seen.

The *genicular branch of the obturator nerve* will be seen as a fine filament upon the medial side of the popliteal artery. It comes from the posterior branch of the obturator nerve and appears in the popliteal fossa by piercing the lower fibres of the adductor magnus. It pierces the oblique popliteal ligament of the knee-joint at about its centre and supplies the articular capsule.

Popliteal Lymph Glands.—These are six or seven in number. One lies superficially near the termination of the small saphenous vein in the popliteal vein. One

lies deep between the popliteal artery and the oblique popliteal ligament. The remaining four or five glands lie along the sides of the popliteal vessels.

Remove these lymph glands and study the branches of the popliteal artery.

The **Popliteal Artery** is the continuation of the femoral artery. It begins at the aperture in the adductor magnus and ends below at the lower border of the popliteus by dividing into anterior and posterior tibial arteries. The course of the upper part of the artery is oblique where it lies against the popliteal surface of the femur. The course of the lower part of the artery is straight where it lies against the oblique popliteal ligament of the knee-joint and the fascia covering the popliteus. It is covered by the semimembranosus above and below by the gastrocnemius and the plantaris. The popliteal vein is firmly connected with the artery by dense fibrous tissue and so these vessels cannot be easily separated and cleaned. The relation of the vein to the artery is the same as that of the tibial nerve, viz., in the upper third of the fossa it lies laterally; opposite the middle third it crosses the artery superficially; and in the lower third it lies medial to the artery. Lastly on either side of the artery are the structures forming the side-walls of the popliteal fossa.

The **branches** of the popliteal artery are:—(1) The *muscular branches* which consist of a superior and an inferior group. The *superior muscular branches* are given off at the upper part of the fossa and supply the hamstring muscles. The *inferior muscular* or *sural branches* supply the gastrocnemius, the soleus and the plantaris. (2) The *cutaneous branches* arise from the popliteal artery or from its sural branches. They perforate the deep fascia to supply the skin over the upper part of the back of the leg. (3) The *genicular branches* are five in number, two superior, two inferior, and one middle. The *medial superior*

genicular artery (superior internal articular artery) arises from the popliteal artery above the level of the medial condyle of the femur and, passing transversely medialwards, winds round the femur beneath the semimembranosus and adductor magnus just above the origin of the medial head of the gastrocnemius. It then enters the substance of the vastus medialis where it will be traced subsequently. The *lateral superior genicular artery* (superior external articular artery) arises at the same level with the preceding branch and passes transversely lateralwards to wind round the femur beneath the biceps femoris above the origin of the lateral head of the gastrocnemius and the plantaris. It then enters the substance of the vastus intermedius where it will be subsequently traced. The *middle genicular artery* (azygos articular artery) arises from the popliteal artery opposite the bend of the knee-joint and pierces the oblique popliteal ligament to supply the synovial stratum. The *medial inferior genicular artery* (inferior internal articular artery) passes medialwards along the upper margin of the popliteus and gains the front aspect of the limb beneath the tibial collateral ligament. The *lateral inferior genicular artery* (inferior external articular artery) passes lateralwards beneath the tendon of the biceps femoris and the fibular collateral ligament above the head of the fibula. Its further course will be subsequently traced.

The **Popliteal Vein** begins at the lower border of the popliteus by the junction of the venæ comites of the anterior and posterior tibial arteries. It leaves the popliteal fossa through the aperture in the adductor magnus where it becomes the femoral vein. Its relations to the popliteal artery have been already described. Besides the tributaries corresponding to the branches of the artery, it also receives the small saphenous vein at the lower part of the fossa.

THE BACK OF THE THIGH.

The dissection of this region should be finished in one day.

Make a vertical incision along the middle line of the back of the thigh through the skin that is left. Reflect the two flaps of skin on either side.

The following structures require to be studied in this dissection :—

Fascia	1. Superficial. 2. Deep.
Muscles	1. Biceps. 2. Semitendinosus. 3. Semimembranosus. 4. Adductor magnus.
Vessels	Perforating branches of the arteria profunda femoris.
Nerves	1. Cutaneous. 2. Sciatic.

The **Superficial Fascia** is fatty and the **Cutaneous Nerves** that are to be searched for are : (1) filaments from the *posterior femoral cutaneous nerve* along the middle line ; (2) twigs from the *posterior division of the lateral femoral cutaneous nerve* on the lateral side ; and (3, 4) filaments from the *medial femoral cutaneous nerve* and the *anterior division of the obturator nerve* on the medial side.

Reflect the superficial fascia in the same way as the skin.

The **Deep Fascia** is a part of the fascia lata of the thigh. It should be reflected in the same way as the superficial fascia. The hamstring muscles– the biceps femoris, the semimembranosus, and the semitendinosus —are now to be cleaned taking care of the posterior femoral cutaneous nerve which lies superficially.

The *posterior femoral cutaneous nerve* lies just under cover of the deep fascia. It descends along the middle line of the back of the thigh to the popliteal fossa where it has been already examined.

The **Biceps Femoris** arises by two heads, a long and a short. The *long head* arises (1) from the lower and medial impression on the quadrilateral portion at the back part of the tuberosity of the ischium by a tendon which is common to it and the semitendinosus; and (2) from the adjacent sacrotuberous ligament. The *short head* arises (1) from the lateral lip of the linea aspera below the gluteal tuberosity and between the adductor magnus and vastus lateralis; (2) from the lower and lateral prolongation of the linea aspera in its upper two-thirds; and (3) from the lateral intermuscular septum. The muscle formed by the union of the two heads ends in a tendon which passes downwards and lateralwards forming the upper and lateral boundary of the popliteal fossa. This tendon is inserted into the lateral surface of the head of the fibula and is divided into two portions, an anterior and a posterior, by the fibular collateral ligament. The anterior portion sends a slip for insertion into the lateral condyle of the tibia. The posterior portion gives off an expansion which blends with the deep fascia of the leg. The muscle is supplied by the sciatic nerve.

The **Semitendinosus** arises from the lower and medial impression on the tuberosity of the ischium by a tendon common to it and the biceps femoris. The muscle ends at about the junction of the middle and lower thirds of the thigh in a long rounded tendon which passes downwards and medialwards forming the upper and medial boundary of the popliteal fossa. It crosses the tibial collateral ligament and is inserted into the upper part of the medial surface of the body of the tibia below the insertion of the gracilis and behind that of the sartorius. At its insertion it also gives off an expansion to the deep fascia of leg. A mucous bursa is interposed between the tendon and the tibial collateral ligament of the knee-joint. This muscle is supplied by the sciatic nerve.

The **Semimembranosus** arises by a flat tendon from the upper and lateral impression on the quadrilateral portion at the back part of the tuberosity of the ischium. The muscle passes downwards and medialwards forming the medial boundary of the upper part of the popliteal fossa. It is inserted by a tendon (1) into the transverse groove at the back part of the medial condyle of the tibia; (2) into the posterior surface of the lateral condyle of the femur by an expansion which passes upwards and lateralwards and forms the greater part of the oblique popliteal ligament; and (3) into the oblique line at the upper part of the posterior surface of the tibia by a fibrous expansion which covers the popliteus muscle. The muscle derives its nerve supply from the sciatic nerve.

Divide the hamstring muscles at their origin and throw them downwards as far as practicable without injuring the vessels and nerves entering them. The adductor magnus is now exposed from behind. It will be studied later on with the muscles on the medial side of the thigh.

Sciatic Nerve.—In the back of the thigh this nerve is seen to lie between the adductor magnus in front and the long head of the biceps femoris behind. It divides usually at about the middle of the thigh into two terminal branches, the tibial and the common peroneal. Before its division it gives off muscular branches to the semitendinosus, both heads of the biceps femoris, semimembranosus, and adductor magnus.

The **Perforating Arteries** are usually three in number and are derived from the arteria profunda femoris. They appear at the back of the thigh by passing backwards through tendinous arches in the adductor magnus close to the linea aspera. The *first perforating artery* perforates the upper part of the adductor magnus, supplies the hamstring muscles and sends an ascending branch which takes part in the crucial anastomosis by anastomosing

with the inferior gluteal, and medial and lateral femoral circumflex arteries. It sends a descending branch to anastomose with the second perforating artery. The *second perforating artery* supplies the hamstring muscles and anastomoses with the first perforating artery above and the third perforating artery below. It gives off the nutrient artery of the femur. The *third perforating artery* supplies the hamstring muscles and anastomoses with the second perforating artery above and the terminal branch of the arteria profunda femoris below.

The *terminal branch of the arteria profunda femoris* pierces the adductor magnus a little above the aperture in the muscle for the femoral artery. It anastomoses above with the third perforating artery and below with the muscular branches of the popliteal artery. It is sometimes described as the *fourth perforating artery.*

The companion veins of the perforating arteries terminate in the vena profunda femoris.

Crucial anastomosis.—This arterial anastomosis is formed at the upper and back part of the thigh by the anastomotic branch of the inferior gluteal artery superiorly; the ascending branch of the first perforating artery inferiorly; the transverse branch of the lateral femoral circumflex artery laterally; and the terminal superficial branch of the medial femoral circumflex artery medially.

THE FRONT OF THE THIGH.

Devote four days to the dissection of this region. The subject should be placed upon its back with blocks under the pelvis.

Surface Anatomy.—The furrow which demarcates the front of the thigh from the abdomen corresponds to the position of the inguinal ligament which can be felt as a tense band stretching from the anterior superior

iliac spine to the pubic tubercle. The subcutaneous inguinal ring lies medial to the pubic tubercle and the femoral ring lies lateral to it. Lymph glands can sometimes be felt along the line of the inguinal ligament as also below its central part for a short distance vertically. In front of the thigh and just below the inguinal ligament is a triangular depression with its base directed towards the abdomen. It corresponds to the femoral triangle. In front of the knee the patella can be felt, as also the condyles of the femur on either side.

Incisions (Fig. 3).—(1) An oblique incision from the symphysis pubis along the inguinal ligament to the anterior superior iliac spine; (2) a transverse incision across the middle of the thigh; (3) a vertical incision joining the medial end of the first incision to the medial end of the second along the medial border of the thigh; (4) a transverse incision below the tuberosity of the tibia from the medial to the lateral aspect of the limb; (5) a vertical incision along the middle line of the thigh connecting the midpoints of the two transverse incisions.

Reflect the flap of skin above the upper transverse incision lateralwards. Reflect the flaps of skin between the two transverse incisions on either side. While reflecting the skin the student will notice two *bursæ:* (1) a bursa placed between the patella and the skin; (2) a bursa interposed between the lower part of the tuberosity of the tibia and the skin.

The following structures require to be studied in this dissection :—

Fasciæ	1. Superficial. 2. Deep or fascia lata. 3. Cribriform fascia. 4. Femoral sheath.
Muscles	1. Sartorius. 2. Iliopsoas. 3. Tensor fasciæ latæ. 4. Quadriceps femoris. 5. Articularis genus.

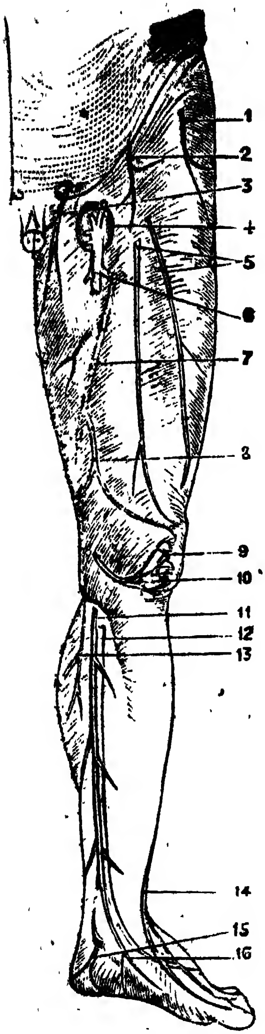
Vessels
1. Femoral artery and its branches.
2. Femoral vein and its tributaries.
3. Great saphenous vein.

Nerves.
1. Cutaneous nerves. 2. Femoral nerve and its branches.

Lymph glands.

The **Superficial Fascia** is fatty and immediately below the inguinal ligament two layers in it can be demonstrated. The superficial fatty layer is continuous with the similar layer (fascia of Camper) in the anterior abdominal wall (p. 19). The deep layer is membranous in character, is continuous with the fascia of Scarpa in the anterior abdominal wall and is blended just below the inguinal ligament with the deep fascia of the thigh. This attachment can be demonstrated by pushing the handle of the knife downwards beneath it.

Cutaneous Nerves.—The lumboinguinal and ilioinguinal nerves are to be searched for close to the inguinal ligament. (1) The *lumboinguinal nerve* (crural branch of the genitocrural nerve) will be seen piercing the deep fascia about an inch below the middle of the inguinal ligament on the lateral side of the femoral artery. It supplies the skin over the femoral triangle and communicates with the intermediate femoral cutaneous nerve. (2) The *ilioinguinal nerve* will be seen at the medial end of the inguinal ligament. It emerges through the subcutaneous inguinal ring (p. 27) and supplies the skin at the upper and medial side of the thigh near the scrotum or labium majus. (3) The *lateral femoral cutaneous nerve* splits into two branches an anterior and a posterior. The *anterior branch* pierces the fascia lata about four inches below the lateral end of the inguinal ligament and descends along the lateral aspect of the front of the thigh as low as the patella where it joins the patellar plexus. It supplies the skin on the lateral aspect of the thigh. The *posterior branch* pierces the fascia lata about two inches below the



1. Lateral femoral cutaneous nerve.
2. Lumboinguinal nerve.
3. Ilioinguinal nerve.
4. Fossa ovalis.
5. Intermediate femoral cutaneous nerve.
6. Great saphenous vein.
7. Medial femoral cutaneous nerve.
8. Anterior branch of medial femoral cutaneous nerve.
9. Patellar plexus of nerves.
10. Infrapatellar nerve.
11. Saphenous nerve.
12. Great saphenous vein.
13. Posterior branch of medial femoral cutaneous nerve.
14. Superficial perineal nerve.
15. Medial calcaneal nerve.
16. Saphenous nerve (terminal part).

Fig. 120.—Cutaneous nerves of the inferior extremity—anterior view (from Buchanan).

anterior superior iliac spine. It supplies the skin of the lower part of the gluteal region and the lateral aspect of the upper part of the thigh. (4) The *intermediate femoral cutaneous nerve* (middle cutaneous nerve) is a branch of the femoral nerve. It becomes cutaneous by piercing the deep fascia in the middle line about four inches below the inguinal ligament. It soon divides into a medial and a lateral branch; both of which descend in front of the thigh as low as the patella and join the patellar plexus. Sometimes the nerve divides beneath the deep fascia into two branches which pierce the deep fascia separately. (5) The *medial femoral cutaneous nerve* (internal cutaneous nerve) is also derived from the femoral nerve. It divides into two branches, an anterior and a posterior. The *anterior branch* pierces the deep fascia at the medial side of the lower third of the thigh and ends by joining the patellar plexus. The *posterior branch* pierces the deep fascia over the medial condyle of the femur and is distributed to the integument on the medial side of the upper part of the leg. Some cutaneous filaments will be seen piercing the deep fascia along the course of the great saphenous vein in the upper part of the thigh. These are derived from the undivided trunk of the medial femoral cutaneous nerve. (6) The *saphenous nerve* (long or internal saphenous nerve) is a branch of the femoral nerve. It becomes cutaneous by perforating the deep fascia on the medial side of the knee. Before it becomes cutaneous it gives off the *infrapatellar branch* which pierces the deep fascia on the medial side of the knee and supplies the skin in front of the patella. The infrapatellar nerve communicates above with the cutaneous branches of the femoral nerve, and laterally with the branches of the lateral femoral cutaneous nerve forming the patellar plexus.

The *patellar plexus* is formed by the communication

with each other of the following nerves in front of and around the patella :—(1) the two branches of the intermediate femoral cutaneous nerve in front of the knee along the middle line ; (2) the anterior branch of the lateral femoral cutaneous nerve along the lateral side ; (3) the anterior branch of the medial femoral cutaneous nerve along the medial side ; and (4) the infrapatellar branch of the saphenous nerve from below.

Superficial Vessels.—These are three in number and arise from the femoral artery below the inguinal ligament. (1) The *superficial circumflex iliac artery* pierces the deep fascia lateral to the fossa ovalis and passes upwards and lateralwards towards the anterior superior iliac spine. (2) The *superficial epigastric artery* passes through the fascia cribrosa, crosses the inguinal ligament and proceeds upwards to the anterior abdominal wall (p. 21). (3) The *superficial external pudendal artery* pierces the fascia cribrosa and passes upwards and medialwards towards the subcutaneous inguinal ring (p. 21). The companion veins of these arteries open into the great saphenous vein and not into the femoral vein direct.

The **Great Saphenous Vein** (internal saphenous vein) lies superficially in its course along the thigh. In the present dissection it appears behind the medial condyle of the tibia and ascends behind the medial condyle of the femur and then along the anteromedial aspect of the thigh. Reaching the fossa ovalis it pierces the fascia cribrosa and terminates in the femoral vein. In the thigh it receives many tributaries from the anterior, medial and posterior aspects of the thigh. Sometimes some tributaries from the posteromedial aspect of the thigh join to form an accessory saphenous vein before opening into the great saphenous vein. Before it passes through the fossa ovalis it receives the superficial circumflex iliac, epigastric, and external pudendal veins.

The **Superficial Lymph Glands** are divisible into two groups. (1) The *superficial inguinal lypmh glands* lie immediately below the inguinal ligament and receive lymph vessels from the penis, scrotum, perineum, buttock, and the lower part of the anterior abdominal wall. (2) The *superficial subinguinal lymph glands* lie on either side of the terminal part of the great saphenous vein. They receive the superficial lymph vessels of the inferior extremity.

Remove the superficial lymph glands and the superficial fascia. Clean the surface of the fascia lata or deep fascia of the thigh. An oval opening in the fascia lata will be seen below the inguinal ligament. This is the fossa ovalis which is closed by a thin layer of fascia called the fascia cribrosa. Take care that this layer of fascia is not injured.

The **Fascia Lata** or deep fascia of the thigh forms a covering for the whole of the thigh. Above and in front it is attached to the inguinal ligament and the medial part of the superior ramus of the os pubis. Above and behind it is continuous with the deep fascia of the gluteal region, the attachment of which has been described (p. 617). Above and medially it is attached to the inferior rami of the os pubis and ischium and to the ischial tuberosity. Below it is attached to all the bony prominences around the knee-joint, viz., the condyles of the femur and tibia and the head of the fibula. The thickness of the fascia lata varies in different parts. Thus, at the lateral aspect of the thigh it is very thick and strong due to its receiving the insertion of the glutæus maximus and the tensor fasciæ latæ. The latter muscle is enclosed between the two layers of the fascia lata in the upper third of the thigh below the anterior part of the iliac crest and this may be verified by removing the superficial layer covering the muscle. Note that a thickened

band of the fascia lata is formed which extends from the anterior part of the iliac crest to the lateral condyle of the tibia and the head of the fibula and is called the *iliotibial tract* (iliotibial band). Below, the fascia lata is strengthened in front of the knee by expansions from the tendon of the quadriceps femoris. Behind the knee, it is continuous with the deep fascia covering the popliteal fossa. Here it receives an expansion from the tendon of the biceps femoris. The medial portion of the fascia lata which covers the adductor muscles is very thin. At the upper and front of the thigh the fascia lata consists of two portions, a lateral or superficial (iliac portion) and a medial or deep (pubic portion). This division into two portions extends for a limited extent only—up to the lower margin of the fossa ovalis. The *superficial portion* is attached above to the inguinal ligament and passes in front of the femoral vessels. The *deep portion* passes behind the femoral vessels and covers the pectineus muscle. It is attached to the pecten pubis, and is continuous with the iliopectineal fascia.

From the deep surface of the fascia lata two strong intermuscular septa are given off which are attached to the linea aspera of the femur. These two septa, the medial and the lateral, will be examined at a later stage of the dissection.

DISSECTION OF THE REGION AFFECTED IN FEMORAL HERNIA.

The **Fossa Ovalis** (saphenous opening) is an oval aperture in the fascia lata at the upper and medial part of the thigh. It is about an inch and a half long, and half an inch in breadth. It is closed by a thin fascia, called the *fascia cribrosa*, which is so named on account of its perforations giving passage to the blood vessels and

lymphatics. It is bounded laterally by the sharp medial margin of the superficial portion of the fascia lata, called

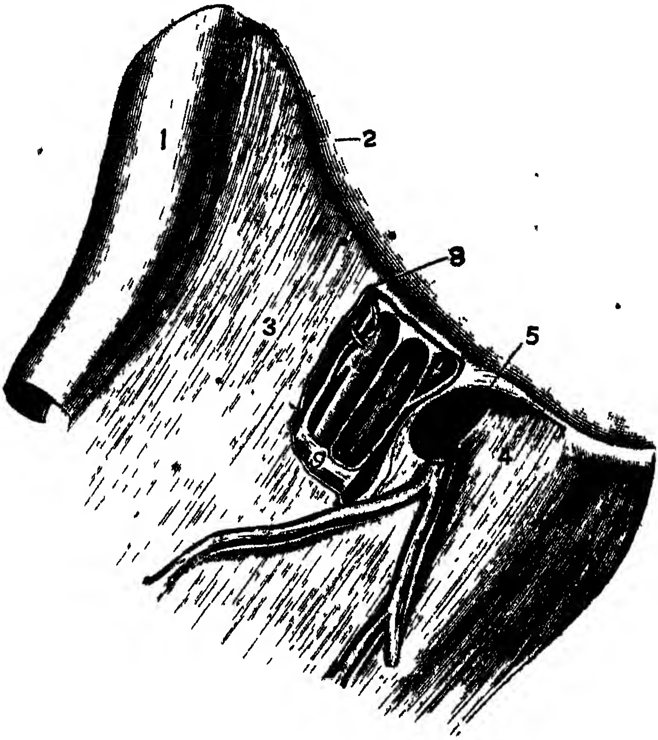


Fig. 121.—Dissection of the region concerned in femoral hernia. (After Gray).

1. Skin reflected.
2. Inguinal ligament.
3. Superficial portion of fascia lata.
4. Deep portion of fascia lata.
5. Fossa ovalis.
6. Fascia cribrosa.
7. Great saphenous vein.
8. Fascia lata (cut).
9. Anterior layer of femoral sheath.
10. Femoral artery.
11. Femoral vein.
12. Femoral canal.

the *falciform margin* which presents two cornua, a superior and an inferior. The *superior cornu* passes upwards and medialwards to be attached to the inguinal ligament. The *inferior cornu* becomes continuous below the opening with the deep portion of the fascia lata.

Make a vertical incision about two inches in length through the superficial portion of the fascia lata beginning from the inguinal ligament about an inch lateral to its midpoint and terminating about half an inch below the lower end of the fossa ovalis. Detach the fascia lata from the inguinal ligament medial to the vertical incision, leaving the attachment of the superior cornu of the falciform margin in tact. Reflect the triangular piece of the fascia lata medialwards. The anterior wall of the femoral sheath is exposed and should be properly cleaned.

The **Femoral Sheath** (crural sheath) is a funnel-shaped sheath containing the femoral vessels. Its base is directed upwards towards the abdomen and its apex is directed downwards. It extends from the inguinal ligament above to the lower end of the fossa ovalis below. The *anterior wall* of the sheath is formed by a prolongation of the fascia transversalis from the anterior abdominal wall. Its *posterior wall* is formed by a prolongation of the fascia iliaca from the posterior abdominal wall and is blended with the deep portion of the fascia lata (iliopectineal fascia). Its *lateral wall* is straight and is pierced by the lumboinguinal nerve. Its *medial wall* is oblique and is pierced by the great saphenous vein and lymphatic vessels. The walls of the sheath are blended with the coats of the femoral vessels at the lower end of the fossa ovalis. The canal inside the sheath is subdivided into three compartments by two anteroposterior septa stretching between its anterior and posterior walls.

Open up the three compartments by making three vertical incisions in the anterior wall of the sheath. Note

that the lateral compartment contains the femoral artery; the intermediate is occupied by the femoral vein; and the medial, called the femoral canal, contains a lymph gland and some lymphatic vessels.

The **Femoral Canal** (crural canal) is about half an inch in length and extends from the inguinal ligament to the upper end of the fossa ovalis. Its base is directed upwards and is called the *femoral ring* (crural ring). This ring is oval in shape and lies behind the inguinal ligament; it is bounded medially by the base of the lacunar ligament and laterally by the septum which separates it from the femoral vein. The ring is closed normally by condensed extraperitoneal connective tissue called the *septum femorale*. The upper surface of this septum is lined by peritoneum and presents a depression, called the *femoral fossa*, when viewed from the abdominal cavity.

The term *femoral hernia* is employed to denote the protrusion of some of the contents of the abdomen into the thigh through the femoral ring and canal. The student can now understand the coverings which such a protrusion gets in its descent into the thigh. These are from within outwards; (1) peritoneum, which forms the sac of the hernia; (2) septum femorale; (3) anterior wall of the femoral sheath; (4) fascia cribrosa; (5) superficial fascia and (6) skin.

The student has now a good view of the lacunar ligament and should study its relation and attachments. It has been described on page 23.

DEEP DISSECTION OF THE THIGH.

Extend the vertical incision made in the fascia lata downwards and remove the whole of the fascia medial to the incision. The iliotibial tract which encloses between

its two layers the tensor fasciæ latæ at the upper part is thus left in tact.

Note the intermuscular septa passing from the deep surface of the fascia lata. The *lateral intermuscular septum* is the stronger and is attached to the lateral lip of the linea aspera and to its lower prolongation. It separates the vastus lateralis from the short head of biceps femoris. The *medial intermuscular septum* is the thinner and is attached to the medial lip of the linea aspera and to its lower prolongation. It separates the vastus medialis from the adductor muscles. Besides these other small processes are given off from the fascia lata which pass between the muscles.

The **Femoral Triangle** (Scarpa's triangle) is a triangular space in front of the upper third of the thigh. It is bounded laterally by the sartorius, and medially by the medial border of the adductor longus. Its base is formed by the inguinal ligament and the apex corresponds to the meeting point of the sartorius and the adductor longus.

The *contents* of the triangle should now be cleaned. These are the femoral artery and its branches; the femoral vein and its tributaries; the femoral nerve and its branches and some fat and lymphatics. Remove the remains of the femoral sheath. Clean the branches of the femoral artery and trace the branches of the femoral nerve which lie lateral to the artery.

The **Femoral Artery** is the continuation into the thigh of the external iliac artery. In the femoral triangle it extends from the midpoint of the inguinal ligament to the apex of the triangle. Here it is rather superficial being covered by the skin, superficial fascia, fascia lata, and the anterior wall of the femoral sheath, at the upper part. It is crossed near the apex of the triangle by the medial femoral cutaneous nerve. Behind it are the posterior wall of the femoral sheath, the deep portion of the fascia

lata, the psoas major, the pectineus with its nerve and the profunda femoral vessels. Lateral to it is the femoral nerve. Medially is the femoral vein which passes behind the artery near the apex of the triangle.

Branches.—In the femoral triangle the femoral artery gives off :—(1) the *superficial iliac circumflex*, (2) the *superficial epigastric*, and (3) the *superficial external pudendal* arteries. These have been examined (p. 21). (4) The *deep external pudendal artery* (deep external pudic artery) passes medialwards and, crossing the pectineus and adductor longus, pierces the fascia lata on the medial side of the thigh to supply the skin of the scrotum or labium majus. (5) The *arteria profunda femoris* is a large vessel which arises from the lateral aspect of the femoral artery about an inch and a half below the inguinal ligament. It passes medialwards behind the femoral vessels and then proceeds downwards behind the adductor longus disappearing from the present dissection. The origins of two of its branches are now seen. These are the lateral and medial femoral circumflex arteries. The *lateral femoral circumflex artery* arises from the lateral aspect of the parent trunk and passes laterally behind the sartorius and rectus femoris. Its termination in ascending, descending, and transverse branches will be examined in a subsequent stage of the dissection. The *medial femoral circumflex artery* arises from the medial and back part of the parent trunk and disappears from the present dissection by passing backwards between the psoas major and the pectineus.

Veins.—The *great saphenous vein* receives the veins corresponding to the three superficial inguinal branches of the femoral artery and opens into the femoral vein. The veins corresponding to the remaining branches of the femoral artery open directly into the femoral vein.

The relation of the *femoral vein* to the artery has been already noted.

Deep subinguinal lymph glands.—These lie on the medial side of the femoral vein and vary from one to three in number; one lies in the femoral canal which has been already seen; the second, when present, occupies the femoral ring; and the third lies on the medial side of the femoral vein below its junction with the great saphenous vein.

Nerves in the femoral triangle.—(1) The *lumboinguinal nerve* lies at first in front of and then lateral to the femoral artery in the lateral compartment of the femoral sheath. It then pierces the lateral wall of the sheath and the fascia lata and becomes cutaneous (p. 687). (2) The *lateral femoral cutaneous nerve* enters the upper and lateral angle of the femoral triangle through the notch just below the anterior superior iliac spine. It soon leaves the triangle, crosses the sartorius and becomes cutaneous by piercing the fascia lata (p. 637). (3) The *femoral nerve* arises from the lumbar plexus (p. 107). It passes behind the inguinal ligament and enters the femoral triangle. It lies at a distance of about one-fourth of an inch on the lateral side of the femoral artery and in the groove between the iliacus and psoas major muscles. It soon divides into an anterior and a posterior division. The branches given off from these divisions will be subsequently examined.

The structures forming the **floor** of the femoral triangle may now be cleaned and identified. These are from the lateral to the medial side; the iliacus, the psoas major, the pectineus, a part of the adductor brevis (sometimes) and the lateral portion of the adductor longus.

The adductor canal lies in the middle third of the thigh covered by the sartorius. To expose the canal hook the sartorius laterally. Beneath the sartorius a plexus

of nerves will be seen, called the *subsartorial plexus*, which overlies the aponeurotic roof of the adductor canal. This plexus is formed by filaments from the posterior branch of the medial femoral cutaneous nerve, the anterior branch of the obturator nerve and a filament from the saphenous nerve; the last-named nerve pierces the aponeurotic roof of the canal to join the plexus.

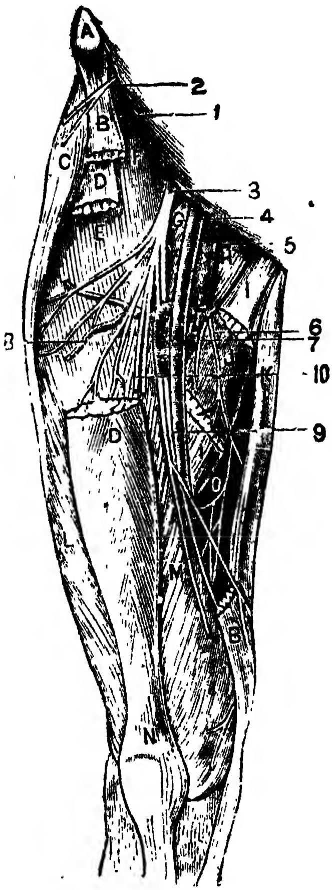
Divide the aponeurotic roof of the adductor canal stretching between the vastus medialis laterally and the adductores longus and magnus medially. The canal is now exposed.

The **Adductor Canal** (Hunter's canal) is a musculo-aponeurotic canal which occupies the middle third of the thigh. It extends from the apex of the femoral triangle to the aperture in the adductor magnus for the femoral vessels. It is bounded anterolaterally by the vastus medialis, posteromedially by the adductor longus above and adductor magnus below. Its *roof* is formed by an aponeurosis stretching from the adductores longus and magnus to the vastus medialis. The roof is covered by the sartorius and the subsartorial plexus. The canal is triangular on transverse section with the apex at the linea aspera and the base at the roof.

The **Contents** of the canal are the femoral vessels, the saphenous nerve and the nerve to the vastus medialis. The femoral vein lies behind the artery in the upper part of the canal and laterally at the lower part. The saphenous nerve lies at first lateral to the femoral artery but lower down crosses it to gain its medial side. The nerve to the vastus medialis lies against the surface of the muscle.

The **Femoral Artery** is deeply placed in the adductor canal. It has *in front* besides the skin and fasciæ, the sartorius, subsartorial plexus the aponeurotic covering of the adductor canal, and the saphenous nerve. *Behind* it are the adductores longus and magnus and the femoral

vein at the upper part. *Lateral* to it are the vastus medialis, the saphenous nerve at the upper part and the femoral vein at the lower part.



A. Anterior superior iliac spine.
B. Sartorius.
C. Tensor fasciæ latæ.
D. Rectus femoris.
E. Vastus intermedius.
F. Iliacus.
G. Psoas.
H. Pectineus.
I. Adductor longus.
J. Adductor brevis.
K. Gracilis.
L. Vastus lateralis.
M. Vastus medialis.
N. Tendon of quadriceps femoris.
O. Adductor magnus.
1. Inguinal ligament.
2. Lateral femoral cutaneous nerve.
3. Femoral nerve.
4. Femoral artery.
5. Femoral vein.
6. Obturator nerve.
7. Profunda femoral artery.
8. Lateral femoral circumflex artery.
9. Saphenous nerve.
10. Intermediate femoral cutaneous nerves.

Fig. 122.—Deep dissection of the front of the thigh.

The *branches* of the femoral artery in the adductor canal are :—(1) *Muscular branches* which supply the neighbouring muscles. (2) The *highest genicular artery* (anastomotica magna) which arises just before the femoral artery leaves the adductor canal. It soon divides into two branches, a saphenous branch and a musculoarticular branch. The *saphenous branch* accompanies the saphenous nerve to the medial side of the upper part of the leg where it anastomoses with the medial inferior genicular branch of the popliteal artery. The *musculoarticular branch* descends along the medial side of the thigh through the substance of the vastus medialis and anastomoses with the medial superior genicular branch of the popliteal artery. From it a branch passes laterally above the patellar surface of the femur and anastomoses with the lateral superior genicular artery forming an anastomotic arch.

In the adductor canal the *femoral vein* receives tributaries corresponding to the branches of the artery. Its relation to the artery has been already noted.

The **Femoral Nerve** has been traced to the point where it divides into an anterior and a posterior division. The *anterior division* gives off muscular and cutaneous branches. The *muscular branches* are :—(1) the *nerve to the pectineus* which passes medialwards behind the femoral sheath to supply the muscle. (2) The *nerve to the sartorius* which arises usually in common with the intermediate femoral cutaneous nerve and supplies the muscle. The *cutaneous branches* are :- (1) The *intermediate femoral cutaneous nerve* which divides into two branches soon after its origin. Their distributions have been examined (p. 639). (2) The *medial femoral cutaneous branch* crosses the femoral artery from the lateral to the medial side at the apex of the femoral triangle and divides into an anterior and a posterior branch. The *anterior branch* descends in

front of the sartorius and pierces the fascia lata at the medial part of the lower third of the thigh. Its subsequent course has been examined (p. 639). The *posterior branch* descends along the medial border of the sartorius, gives off a filament which joins the subsartorial plexus and perforates the fascia lata at the medial side of the knee. Its subsequent distribution has been examined (p. 639).

The *posterior division of the femoral nerve* gives off the saphenous nerve and muscular branches. The *saphenous nerve* (internal or long saphenous nerve) lies on the lateral side of the femoral artery in the femoral triangle and at the upper part of the adductor canal. At the lower part of the canal it crosses in front of the femoral artery and gains its medial side. It leaves the canal through its aponeurotic roof in company with the saphenous branch of the highest genicular artery. It then passes downwards beneath the sartorius and emerging from its posterior border pierces the deep fascia at the medial side of the knee. Its subsequent course will be examined during the dissection of the leg. In the adductor canal it gives off a filament which pierces the aponeurotic roof of the canal and joins the subsartorial plexus. Before piercing the fascia lata it gives off the infrapatellar branch at the medial side of the knee which pierces the sartorius and the fascia lata and joins the patellar plexus. The muscular branches of the posterior division are :—(1) The *nerve to the rectus femoris* which enters its deep surface at the upper part and supplies a twig to the hip-joint. (2) The *nerve to the vastus medialis* which lies on the surface of the vastus medialis in the adductor canal. From it a filament supplies the knee-joint. (3) The *nerve to the vastus lateralis* descends with the descending branch of the lateral femoral circumflex artery, supplies the muscle and sends a twig to supply the knee-joint. (4) The *nerves to the vastus intermedius* are two or three in number and enter

the anterior surface of the muscle. Of these the medial one supplies the articularis genus and the knee-joint by passing through the vastus intermedius.

The muscles in front of the thigh should now be studied. The **Sartorius** arises from the anterior superior iliac spine and from the upper half of the notch lying below it. It passes downwards and medialwards forming the lateral boundary of the femoral triangle. It then proceeds almost vertically downwards to the back part of the medial condyle of the femur lying on the roof of the adductor canal opposite the middle third of the thigh. It ends in an expanded aponeurosis which is inserted (1) into the upper part of the medial surface of the body of the tibia in front of the insertions of the gracilis and semitendinosus. It is also inserted (2) into the deep fascia of the leg by an expansion from its lower border and (3) into the articular capsule of the knee-joint by an expansion from its upper margin. The muscle is supplied by a branch from the anterior division of the femoral nerve.

The **Tensor Fasciæ Latæ** (Tensor fasciæ femoris) arises (1) from the anterior part of the outer lip of the iliac crest to the extent of about an inch ; (2) from the outer aspect of the anterior superior iliac spine and the notch below it ; and (3) from the deep fascia covering it. It passes downwards and slightly backwards to be inserted into the angle of division of the iliotibial tract at the junction of the upper with the middle third of the thigh. It is supplied by the terminal portion of the lower branch of the superior gluteal nerve which enters its deep surface.

Divide the iliotibial tract below the insertion of the tensor fasciæ latæ.

The **Quadriceps Femoris** is a large fleshy mass occupying the front of the thigh. It consists of four portions which subsequently unite into a single tendon at their

insertion. The four portions are :--The rectus femoris placed in front and superficially, the vastus lateralis laterally, the vastus medialis medially, and the vastus intermedius covering the anterior and lateral surfaces of the femur.

The **Rectus Femoris** has two heads of origin. The *anterior* or *straight head* arises by a tendon from the anterior inferior spine of the ilium. The *posterior* or *reflected head* arises by a tendon from the groove on the dorsum of the ilium above the acetabulum. The two heads unite into a single tendon from which a fusiform muscle is formed. Above the knee it ends in a flattened tendon which is developed on the deep surface of the muscle. This tendon is then blended with the tendon of the vasti and is inserted into the upper border of the patella. The muscle is supplied by a branch from the posterior division of the femoral nerve.

The **Vastus Lateralis** (vastus externus) arises by an aponeurosis which extends over the upper three-fourths of the superficial surface of the muscle. It arises (1) from the upper third of the intertrochanteric line, (2) from the anterior and inferior margins of the greater trochanter, (3) from the lateral lip of the gluteal tuberosity, (4) from the upper half of the lateral lip of the linea aspera, and (5) from the lateral intermuscular septum. It ends below in a flattened tendon which is blended with the common tendon of the quadriceps femoris and is inserted into the lateral border of the patella. It gives an expansion to the articular capsule of the knee-joint. It is supplied by the posterior division of the femoral nerve.

The **Vastus Medialis** (vastus internus) arises (1) from the lower half of the intertrochanteric line, (2) from the medial lip of the linea aspera and its prolongation below, (3) from the medial intermuscular septum, and (4) from the tendon of the adductor magnus. The fibres pass

downwards and forwards and end in a tendon which is blended with the common tendon of the quadriceps femoris and is inserted into the medial border of the patella. It gives an expansion to the capsule of the knee-joint. The muscle is supplied by the posterior division of the femoral nerve.

The **Vastus Intermedius** (crureus) arises (1) from the upper two-thirds of the anterior and lateral surfaces and the lateral border of the femur and (2) from the lower part of the lateral intermuscular septum. It ends below in a tendon which forms part of the common tendon of the quadriceps femoris and is inserted into the upper border of the patella. The muscle gets its nerve-supply from the posterior division of the femoral nerve.

The **Tendon of the Quadriceps Femoris** is formed by the blending together of the tendons of the four divisions of the muscle. It is attached to the margin of the base of the patella and is prolonged over its anterior surface to be continuous with the ligamentum patellæ, thus gaining an insertion into the rough part of the tuberosity of the tibia. Expansions are given off from it on either side of the patella, which blend with the capsule of the knee-joint.

Divide the rectus femoris at about its middle and reflect the lower part downwards. Make a longitudinal incision through the lower part of the vastus intermedius on the anterior aspect of the femur. On separating the margins of the incision the articularis genus is exposed.

The **Articularis Genus** (subcrureus) arises by fleshy slips from the anterior surface of the femur about three inches above its patellar surface. It is inserted into the upper part of the capsule of the knee-joint. It derives its nerve-supply from the most medial of the nerves to the vastus intermedius.

Lateral Femoral Circumflex Artery (Fig. 122).—Its

terminal branches may now be examined. Its origin from the arteria profunda femoris has been noticed. It passes lateralwards between the divisions of the femoral nerve and under cover of the sartorius and rectus femoris and divides into an ascending, a descending and a transverse branch. The *ascending branch* passes upwards beneath the tensor fasciæ latæ and anastomoses with the superior gluteal artery. The *descending branch* passes downwards on the vastus lateralis accompanied by the nerve to that muscle. It supplies the muscle and anastomoses with the superior lateral genicular branch of the popliteal artery on the lateral side of the knee. It also supplies twigs to the neighbouring muscles. The *transverse branch* passes transversely lateralwards between the vastus lateralis and the vastus intermedius, pierces the former muscle below the greater trochanter, where it has been seen to join the crucial anastomosis.

Vascular Anastomosis around the Knee-joint.—In well injected subjects the student should trace the anastomoses of the blood vessels around the knee. The anastomotic arch formed by the musculo-articular branch of the highest genicular artery with the superior lateral genicular artery above the knee-joint should be defined. The anastomosis between the terminal branches of the superior genicular arteries and their inosculations with the inferior genicular arteries of the corresponding sides should be traced. The descending branch of the lateral femoral circumflex artery has been already seen to join this anastomosis from above. A branch from the anterior tibial artery, called the anterior tibial recurrent artery, joins the inferior genicular arteries from below.

MEDIAL SIDE OF THE THIGH.

Devote one day to the dissection of this region. The

following structures will be displayed in this dissection :—

Muscles	1. Gracilis. 2. Adductor longus. 3. Pectineus. 4. Adductor brevis. 5. Adductor magnus. 6. Obturator externus. 7. Insertion of iliopsoas.
Vessels	1. Arteria profunda femoris and its branches. 2. Obturator artery.
Nerves.	1. Obturator. 2. Accessory obturator.

The **Gracilis** (Fig. 122) is a long flat ribbon-like muscle situated on the medial margin of the thigh. It arises (1) from the anterior surface of the medial portion of the superior ramus of the os pubis close to the lower half of the symphysis pubis, and (2) from the anterior surface of the inferior ramus of the same bone close to the medial border. The muscle passes along the medial side of the thigh and along the back part of the medial condyles of the femur and tibia and ends in a flattened tendon which is inserted into the upper part of the medial surface of the body of the tibia above the insertion of the semitendinosus and below and behind that of the sartorius. The tendon also gives off an expansion to the deep fascia of the leg. The muscle is supplied by the anterior branch of the obturator nerve.

The **Adductor Longus** arises by a thick stout tendon from the upper and medial angle of the anterior surface of the medial portion of the superior ramus of the os pubis. It soon expands into a broad muscle and is inserted by an aponeurosis into the intermediate line of the linea aspera, between the vastus medialis and adductor magnus. It is supplied by the anterior branch of the obturator nerve.

The **Pectineus** is a quadrilateral muscle which arises from the pecten pubis and the triangular surface in front of it, and from the deep surface of the fascia covering

it. The muscle passes downwards, lateralwards and backwards and is inserted into the line descending from the lesser trochanter to the linea aspera. It is supplied by a branch from the femoral nerve and sometimes also by the anterior branch of the obturator nerve and by the accessory obturator nerve when present.

Divide the adductor longus and pectineus near their origin and reflect them downwards and lateralwards. While reflecting the pectineus the student should bear in mind that the accessory obturator nerve when present lies under cover of this muscle. The arteria profunda femoris and the anterior branch of the obturator nerve which lie in front of the adductor brevis are now exposed.

The **Adductor Brevis** arises from the anterior surface of the medial portion of the superior ramus and from the anterior surface of the inferior ramus of the os pubis lateral to the origin of the gracilis. It passes downwards, lateralwards and backwards to be inserted into the whole of the line extending from the lesser trochanter to the linea aspera behind the insertion of the pectineus. It is supplied by the obturator nerve.

Insertion of the Iliopsoas.—The tendon of the psoas major receives the fibres of the iliacus and is conjointly inserted into the lesser trochanter of the femur; some of the fibres of the iliacus are inserted into the body of the bone immediately below for nearly an inch.

The **Arteria Profunda Femoris** has been traced from its origin in the femoral artery to the point where it passes under cover of the adductor longus (p. 647). The remaining part of its course is now exposed. It is now seen to lie between the adductor longus in front and the adductores brevis and magnus behind. The terminal part of the artery pierces the adductor magnus a little above the aperture in it for the femoral vessels and is sometimes called the *fourth perforating artery*. The

branches given off from it are :—(1) The *lateral femoral circumflex artery* which has been already examined. (2) The *medial femoral circumflex artery.* It passes backwards at first between the pectineus and the psoas major and then between the adductor brevis and the obturator externus and divides into terminal branches. It gives off (*a*) *muscular branches* to the neighbouring muscles. (*b*) An *acetabular branch* which enters the acetabular notch beneath the transverse acetabular ligament to supply the interior of the hip-joint. (*c*) The *terminal branches,* superficial and deep. The *superficial branch* has been seen to appear in the gluteal region between the adductor magnus and the quadratus femoris and join the crucial anastomosis. The *deep branch* has been traced to the trochanteric fossa along the tendon of the obturator externus. (3) The *perforating arteries* are three in number. They pass backwards by piercing the adductor muscles close to the linea aspera. The *first* and *second* perforating arteries pierce the adductores brevis and magnus muscles. The *third* perforating artery pierces the adductor magnus only. The anastomoses of the perforating arteries with each other have been examined at the back of the thigh. (4) The *muscular branches* supply the adductor muscles between which the parent trunk passes.

Obturator Nerve.—Its origin from the lumbar plexus and course in the pelvis have been described (p. 107). It emerges from the pelvis through the obturator canal along with the obturator vessels and immediately divides into an anterior and a posterior branch. The *anterior branch* supplies an articular twig to the hip-joint and passes downwards lying in front of the adductor brevis. It supplies branches to the gracilis, adductor longus and adductor brevis and occasionally to the pectineus. At the lower border of the adductor longus it gives a twig to join the subsartorial plexus and is then continued

as a fine filament on the femoral artery. It is joined by a filament from the accessory obturator nerve.

Divide the adductor brevis close to its origin and reflect it downwards and lateralwards.

The *posterior branch of the obturator nerve* passes through the obturator externus and supplies it. It then descends behind the adductor brevis and in front of the adductor magnus and supplies branches to the latter. Its genicular branch pierces the adductor magnus above the opening for the femoral vessels and accompanies the popliteal artery to the knee-joint (p. 629).

Accessory Obturator Nerve.—Its origin from the lumbar plexus has been described (p. 107). It leaves the pelvis under cover of the pectineus, supplies a twig to the hip-joint and ends by joining the anterior branches of the obturator nerve. Occasionally it supplies a twig to the pectineus.

The **Adductor Magnus** is the largest of the adductor muscles. It is triangular in shape, being narrow at its origin and expanded at insertion. It arises (1) from the anterior surface of the inferior rami of the os pubis and ischium ; and (2) from the lateral margin of the inferior triangular portion of the tuberosity of the ischium. The upper fibres arising from the inferior ramus of the os pubis are horizontal in direction and are inserted into a line medial to the gluteal tuberosity of the femur. The lower and medial fibres arising from the tuberosity of the ischium are almost vertical in direction and end in a tendon which is inserted into the adductor tubercle and the adjoining part of the epicondylar ridge. The intermediate fibres arising from the inferior ramus of the ischium pass obliquely downwards and lateralwards and are inserted into the intermediate line of the linea aspera and into the upper part of its medial prolongation below. At its insertion into the femur the student should note the tendinous

arches transmitting the three perforating arteries, the terminal part of the arteria profunda femoris and the femoral vessels. The lowest opening is the largest and is for the last named vessels. The muscle is supplied by the sciatic nerve and by the posterior branch of the obturator nerve.

Divide the adductor magnus at its origin and reflect it lateralwards. The obturator externus is now fully exposed.

The **Obturator Externus** is a fan-shaped muscle which arises by its broad base (1) from the anterior surface of the rami of the os pubis and the inferior ramus of the ischium close to the medial margin of the obturator foramen; and (2) from the outer surface of the medial two-thirds of the obturator membrane. The fibres pass backwards and lateralwards and converge to a tendon which ascends along the back part of the neck of the femur to be inserted into the trochanteric fossa. It is supplied by the posterior branch of the obturator nerve which passes through its substance.

Detach the obturator externus from its origin. The obturator vessels which lie under cover of the muscle are exposed.

Obturator Artery.—Its origin and course through the pelvis have been described (p. 119). It issues out of the pelvis through the obturator canal accompanied by the obturator nerve and divides into an anterior and a posterior branch. The *anterior branch* runs forwards and then downwards along the medial margin of the obturator foramen and anastomoses with the posterior branch. The *posterior branch* runs downwards along the lateral margin of the obturator foramen and then curves upwards to anastomose with the anterior branch; this anastomosis completes an arterial circle along the circumference of the obturator foramen. *Muscular branches*

are given off from both the branches to the adductor muscles and the obturator externus. An *articular twig* is given off from the posterior branch which enters the hip-joint through the acetabular notch.

Coxal Articulation or Hip-Joint.—The dissector should first expose the front part of the capsule of the hip-joint. Divide the femoral vessels and nerve about an inch below the inguinal ligament. Divide the sartorius and the rectus femoris two inches below their origin. Detach the iliopsoas from its insertion into the lesser trochanter and raise it from the anterior aspect of the articular capsule. Note that a mucous bursa is interposed between the iliopsoas and the capsule.

The hip-joint is a typical ball-and-socket joint formed by the reception of the head of the femur into the acetabular cavity. The ligaments belonging to this joint are :- (1) the articular capsule, (2) the glenoidal labrum, (3) the transverse acetabular ligament; and (4) the ligamentum teres femoris.

The **Articular Capsule** is very strong and not loose like that of the shoulder-joint. It is attached in front of the outer surface of the glenoidal labrum ; above and behind to the rim of the acetabulum beyond the glenoidal labrum : and below to the transverse acetabular ligament. In the femur it is attached in front to the intertrochanteric line ; above, to the base of the neck ; behind, to the posterior surface of the neck half an inch above the intertrochanteric crest ; and below, to the lower part of the neck. The capsule is thick at the upper and front aspect of the joint where the fibres composing it are directed longitudinally from one bone to the other. It is thin at the lower and back part where the fibres are disposed circularly forming what is called the *zona orbicularis.* The mucous bursa lying between the front part of the capsule and the iliopsoas has been already noted. Sometimes it communi-

cates with the synovial stratum of the capsule. The blending of the capsule with the tendon of the gluteus minimus has also been noted.

Certain accessory bands of the capsule should now be examined. These are :—

(1) The *iliofemoral ligament* (Y-shaped ligament of Bigelow) is the thickest and strongest band of the capsule. Its shape is in reality like that of an inverted **Y** and is attached to the anterior inferior spine of the ilium by the stem of the **Y**. Below, the two limbs diverge ; the lateral limb, called the *iliotrochanteric ligament*, is fixed to the upper end of the intertrochanteric line ; the medial limb is attached to the lower end of the same line.The intervening portion of the capsule between the two limbs is thin.

(2) The *pubocapsular ligament* (pubofemoral ligament) is attached above to the iliopectineal eminence and the obturator membrane. Below it blends with the lower and front part of the capsule.

(3) The *ischiocapsular ligament* arises from the ischium below the acetabulum and the fibres pass upwards and lateralwards along the back part of the capsule with which they are blended.

The joint should now be opened by a circular cut along the middle of the capsule.

The **synovial stratum** lines the inner surface of the fibrous capsule and is reflected on both surfaces of the glenoidal labrum. Then it lines the acetabular cavity and the mass of fat lying at its bottom, ensheaths the ligamentum teres femoris and is reflected on the head and the intracapsular portion of the neck of the femur. Along its line of reflection on the neck it is raised into longitudinal folds owing to the fibrous stratum of the capsule being prolonged upwards on the neck from its attachment. These reflected fibres of the capsule are called *retinacula*.

The **glenoidal labrum** (cotyloid ligament) is a circular fibrocartilaginous band which deepens the acetabular

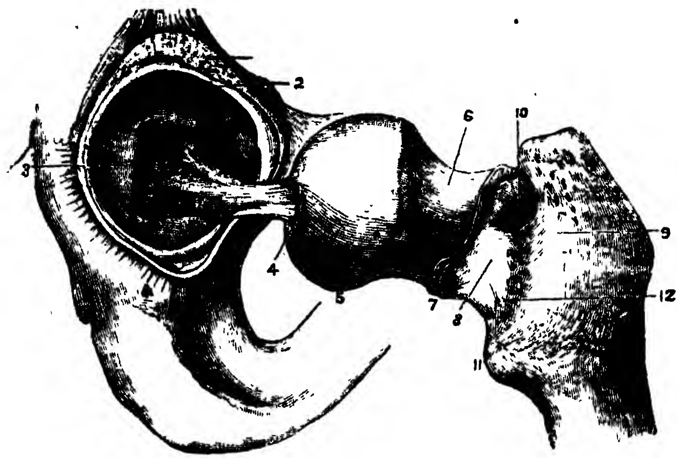


Fig. 128.—Ligaments of the hip-joint (Sappey).

1. Ilio-femoral ligament (cut).
2. Glenoidal labrum.
3. Ligamentum teres femoris.
4. Attachment of the same into the head of the femur.
5. Head of the femur.
6. Neck of the femur.
7. Attachment of articular capsule.
8. Neck of femur (extracapsular part).
9. Greater trochanter.
10. Trochanteric fossa.
11. Lesser trochanter.
12. Intertrochanteric crest.

cavity. It is attached to the margin of the acetabulum and opposite the acetabular notch to the transverse acetabular ligament which bridges over the notch. Its attached margin is thicker than the free margin which serves to narrow the mouth of the acetabulum. Its surfaces are lined by the synovial stratum.

The **transverse acetabular ligament** bridges over the acetabular notch and is attached to its margins. Laterally it gives attachment to the glenoidal labrum and medially bounds the acetabular notch converting it into a foramen

for the passage of articular vessels and nerves to the joint.

The **ligamentum teres femoris** is a triangular band attached by its apex to the upper part of the fovea capitis femoris. The base of the ligament is expanded and consists of two thickened bands and an intermediate thin portion. The thickened bands are fixed to the margins of the acetabular notch and the intermediate thin portion is attached to the transverse acetabular ligament. The ligament is invested by the synovial stratum.

A mass of fat (Haversian gland) occupies the rough depression at the bottom of the acetabulum. It is covered by the synovial stratum and the ligament teres rests against it.

The *arteries* which enter the hip-joint through the acetabular notch are the articular twigs derived from the medial femoral circumflex artery and posterior branch of the obturator artery. The *nerves* which enter the joint through the same notch are the articular twigs derived from the anterior branch of the obturator and accessory obturator nerves.

The limb should now be removed from the body by dividing the ligamentum teres.

THE FRONT OF THE LEG AND DORSUM OF THE FOOT.

Surface Anatomy.—The student should feel for himself the bony landmarks before the skin is reflected:—The anterior crest of the tibia or the shin; the medial margin and medial surface of the body of the tibia; the lower fourth of the body of the fibula; and the two malleoli. The tip of the medial malleolus lies on a higher level than that of the lateral malleolus. Along the lateral margin of the foot the subcutaneous lateral surface of

the calcaneus ; the cuboid in front of it ; and the tuberosity at the base of the fifth metetarsal bone can be felt. Along the medial margin of the foot the medial process of the calcaneal tuberosity ; the medial margin of the sustentaculum tali ; the tuberosity of the navicular bone ; the medial surface of the first cuneiform bone ; and the first metatarsal bone should be felt and identified.

Put a block beneath the knee and fix the foot in an extended position with hooks.

Reflect the skin by the following incisions (Fig. 3) :— (1) a vertical incision along the middle line of the front of the leg and ankle and along the middle line of the dorsum of the foot up to the cleft between the second and third toes ; (2) a transverse incision across the front of the ankle-joint ; (3) a curved incision along the roots of the toes. The skin from the dorsal aspects of the toes is to be reflected by giving a median longitudinal incision along the dorsum of each toe. The following structures will be displayed in this dissection :—

Fasciæ	1. Superficial. 2. Deep, including the transverse crural and cruciate crural ligaments and the peroneal retinacula.
Muscles	1. Tibialis anterior. 2. Extensor hallucis longus. 3. Extensor digitorum longus. 4. Peronæus tertius. 5. 6. Peronæi longus and brevis. 7. 8. 9. Insertions of sartorius, gracilis and semitendinosus. 10. Extensor digitorum brevis.
Vessels	1. Superficial veins. 2. Anterior tibial artery and its branches. 3. Dorsalis pedis artery and its branches. 4. Perforating branch of the peroneal artery.
Nerves	1. Cutaneous nerves. 2. 3. Superficial and deep peroneal nerves.

Superficial veins.—A *dorsal venous arch* is seen lying across the distal ends of the metatarsal bones. This venous arch receives along its convexity the dorsal metatarsal veins which are formed by the union of the dorsal digital veins. A network of veins is situated in the concavity of the arch and communicates with it. From the medial end of the dorsal arch the *great saphenous vein* begins and ascends in front of the medial malleolus and along the medial side of the leg. Its course along the thigh and its termination in the femoral vein have been examined (p. 640). The saphenous nerve lies along the side of this vein. From the lateral end of the dorsal arch the *small saphenous vein* begins and ascends behind the lateral malleolus into the back part of the leg, where it will be traced subsequently. The sural nerve lies along the course of this vein.

Cutaneous Nerves (Fig. 120).—(1) The *saphenous nerve* descends along the medial side of the leg by the side of the great saphenous vein and terminates at the medial side of the dorsum of the foot. Sometimes it can be traced as far as the ball of the great toe. It communicates with the medial branch of the superficial peroneal nerve. (2) The *sural nerve* follows the course of the small saphenous vein and runs below the lateral malleolus. It then receives the name of the *lateral dorsal cutaneous nerve* of the foot and proceeds along the lateral side of the dorsum of the foot and the little toe. It communicates medially with the intermediate dorsal cutaneous nerve. (3) The *superficial peroneal nerve* pierces the deep fascia at the lower third of the leg and divides into medial and intermediate dorsal cutaneous nerves. The *medial dorsal cutaneous nerve* divides into two dorsal digital branches. One of these passes to the medial side of the dorsum of the foot, supplies the skin over the part and communicates with the saphenous nerve. It is continued along

the medial side of the great toe and also communicates with the terminal part of the deep peroneal nerve at the cleft between the first and second toes. The other dorsal digital branch passes towards the cleft between the second and third toes and divides into two branches which supply the contiguous sides of these toes. The *intermediate dorsal cutaneous nerve* passes along the lateral side of the dorsum of the foot and divides into two dorsal digital branches; one of which bifurcates to supply the contiguous sides of the third and fourth toes while the other bifurcates to supply the contiguous sides of the fourth and fifth toes. It communicates laterally with the lateral dorsal cutaneous nerve. (4) The *medial terminal branch of the deep peroneal nerve* pierces the deep fascia over the first interosseous space, communicates with the medial dorsal cutaneous nerve and bifurcates to supply the contiguous sides of the great and second toes. (5) The *lateral sural cutaneous nerve* has been seen to arise from the common peroneal nerve. It supplies the skin on the anterolateral aspect of the upper part of the leg.

Remove the fatty superficial fascia and clean the surface of the deep fascia.

The **Deep Fascia** of the leg is attached to the anterior and medial crests of the body of the tibia and is absent on its medial surface where it is blended with the periosteum. It is also absent from the subcutaneous surface of the lateral malleolus. It is thick and strong at the upper part of the front of the leg where it gives origin to the muscles of that region from its deep surface. Above the ankle it presents a thickened band in front called the transverse crural ligament. In front of the ankle another thickened band is seen, called the cruciate crural ligament which is continuous below with the deep fascia on the dorsum of the foot; the latter is thin and membranous. On the lateral side of the ankle it presents thickened

bands called the peroneal retinacula. The deep fascia of the leg gives off intermuscular septa from its deep surface which will be examined during the reflection of the fascia. The thickened bands may now be examined in detail.

The *transverse crural ligament* (upper part of the anterior annular ligament) is a broad thickened band which lies in front of the lower part of the leg and stretches between the lower ends of the anterior border of the tibia and the anterolateral border of the fibula.

The *cruciate crural ligament* (lower part of the anterior ligament) presents the appearance of Y with its stem directed laterally and attached to the anterior part of the upper surface of the calcaneus. Of the two diverging limbs the upper one passes upwards and medialwards to be attached to the anterior margin of the medial malleolus and splits to enclose the tendon of the tibialis anterior in its course. The lower limb passes downwards and medialwards and is blended with the plantar aponeurosis at the medial margin of the foot.

The *peroneal retinacula* are two in number, superior and inferior. They bind the tendons of the peronaei longus and brevis in position. The *superior peroneal retinaculum* (external annular ligament) extends from the posterior border of the lateral malleolus to the back part of the lateral surface of the calcaneus. The *inferior peroneal retinaculum* is attached at one end to the anterior part of the upper surface of the calcaneus where it is continuous with the stem of the cruciate crural ligament. Its other extremity is fixed to the trochlear process and anterior part of the lateral surface of the calcaneus.

The deep fascia on the front of the leg is now to be removed. Keep the transverse and cruciate crural ligaments in tact so that the tendons are retained in position. Make a vertical incision in the deep fascia between

the two bones of the leg and reflect the two portions on either side. While reflecting the deep fascia note that the muscles in front of the leg take their origin from its deep surface at the upper part of the leg. Observe that a strong intermuscular septum, called the *anterior fibular intermuscular septum*, extends from the deep surface of the fascia to the anterolateral border of the fibula and separates the muscles in front of the leg from the peronæi longus and brevis. Remove the deep fascia from the dorsum of the foot.

The **Tibialis Anterior** (Tibialis anticus) arises from the lateral condyle of the tibia and from the upper half of the lateral surface of its body; (2) from the anterior surface of the adjacent interosseous membrane; (3) from the deep fascia covering it; and (4) from the intermuscular septum between it and the extensor digitorum longus. The muscle ends in a stout tendon which passes beneath the transverse and cruciate crural ligaments and is inserted into the medial and undersurfaces of the first cuneiform bone and into the medial side of the base of the first metatarsal bone. It is supplied by the deep peroneal nerve.

The **Extensor Digitorum Longus** arises (1) from the lateral condyle of the tibia; (2) from the head and upper three-fourths of the anterior surface of the body of the fibula; (3) from the upper part of the interosseous membrane; (4) from the intermuscular septum between it and the tibialis anterior; (5) from the anterior fibular intermuscular septum; and (6) from the deep fascia covering it. The muscle ends in a tendon which passes beneath the transverse and cruciate crural ligaments to the dorsum of the foot and divides into four slips for the lateral four toes. On the dorsal aspect of the first phalanx each slip widens into an expansion receiving the insertions of the corresponding lumbrical and interosseous muscles.

Opposite the metatarsophalangeal articulations the tendons for the second, third, and fourth toes are each joined late-

Fig. 124.—Dissection of the front of the leg and foot. (Altered from Hirschfeld and Leveillé).

A. Tibialis anterior.

B. Extensor digitorum longus.

C. Extensor hallucis longus.

D. Peronæus tertius.

E. Peronæus longus.

F. Peronæus brevis.

G. Extensor digitorum brevis.

H. H. Muscles of the calf.

I. Cruciate crural ligament.

1. Shin.

2. Anterior tibial artery.

3. Anterior tibial recurrent artery.

4. Deep peroneal nerve.

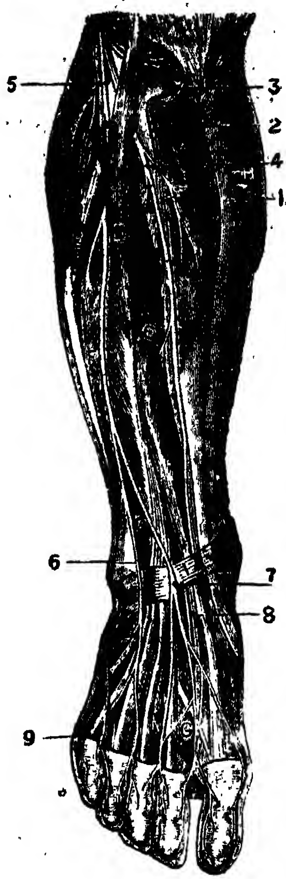
5. Superficial peroneal nerve.

6. Intermediate dorsal cutaneous nerve.

7. Medial dorsal cutaneous nerve.

8. Dorsalis pedis artery.

9. Lateral dorsal cutaneous nerve.



rally by a tendon of the extensor digitorum brevis. The mode of insertion of the expansion of the extensor tendon is the same as that for the fingers. Thus opposite the first interphalangeal articulation the expansion splits

into an intermediate and two collateral slips. The intermediate slip is attached to the dorsum of the base of the second phalanx. The two collateral slips reunite on the dorsum of the second phalanx to be inserted into the dorsum of the base of the last phalanx. The muscle is supplied by the deep peroneal nerve.

The **Extensor Digitorum Brevis** arises (1) from the front part of the upper surface and the adjacent lateral surface of the calcaneus ; (2) from the stem of the cruciate crural ligament, and (3) from the lateral talocalcaneal ligament. The muscle divides into four tendons which pass forwards and medialwards to the four medial toes. The most medial of these tendons crosses the terminal part of the dorsal pedis artery and is inserted into the dorsum of the base of the first phalanx of the great toe. The tendons for the second, third, and fourth toes are blended with the corresponding tendons of the flexor digitorum longus on their lateral sides. The muscle is supplied by the lateral terminal branch of the deep peroneal nerve.

The **Extensor Hallucis Longus** is placed between the tibialis anterior and the extensor digitorum longus. It arises from the middle two-fourths of the anterior surface of the fibula medial to the origin of the extensor digitorum longus and from the adjacent part of the interosseous membrane. The muscle ends in a tendon which passes beneath the transverse and cruciate crural ligaments. It crosses to the medial side of the foot to gain the dorsal aspect of the great toe. The tendon usually gives off a slip to the base of the first phalanx and is finally inserted into the dorsum of the base of the last phalanx. It is upplied by the deep peroneal nerve.

The **Peronæus Tertius** arises (1) from the lower fourth of the anterior surface of the fibula below the origin of the extensor digitorum longus ; (2) from the adjacent

part of the interosseous membrane; and (3) from the corresponding part of the anterior fibular intermuscular septum. Its tendon passes behind the transverse and cruciate crural ligaments with that of the extensor digitorum longus and is inserted into the dorsum of the base of the fifth metatarsal bone. It is supplied by the deep peroneal nerve.

The insertions of the sartorius, gracilis, and semitendinosus into the upper part of the medial surface of the body of the tibia should now be fully examined. Note that the tendon of insertion of the sartorius expands into a broad aponeurosis and is attached in front of the insertions of the gracilis and semitendinosus. The mucous bursæ between the tendons of insertion should be noted.

Divide the anterior fibular intermusclar septum and note the *posterior fibular intermuscular septum* passing from the deep fascia to the posterolateral border of the fibula.

Remove the deep fascia covering the peronæi longus and brevis.

The **Peronæus Longus** is situated on the lateral side of the leg. It arises (1) from the head and upper two-thirds of the lateral surface of the fibula; (2) from the anterior and posterior fibular intermuscular septa; and (3) from the deep fascia covering it. The muscle ends in a tendon which passes along the groove behind the lateral malleolus to the lateral surface of the calcaneus being retained in position by the superior and inferior peroneal retinacula. On the lateral surface of the calcaneus it lies below the peronæus brevis from which it is separated by the trochlear process. The tendon turns round the lateral surface of the cuboid to gain the sole of the foot where it will be subsequently traced to its insertion into the first cuneiform and the base of the first metatarsal bone. The tendon is enclosed by a mucous sheath behind the lateral mal-

leolus and on the lateral surface of the calcaneus. The muscle is supplied by the superficial peroneal nerve.

The **Peronæus Brevis** arises (1) from the lower two-thirds of the lateral surface of the body of the fibula, the upper part lying anterior to the origin of the peronæus longus; and (2) from the anterior and posterior fibular intermuscular septa. Its tendon passes behind the lateral malleolus lying in front of that of the peronæus longus and enclosed in the same mucous sheath with it. On the lateral surface of the calcaneus it lies above the trochlear process and has a separate mucous sheath. It is inserted into the lateral aspect of the tuberosity at the base of the fifth metatarsal bone. The muscle is supplied by the superficial peroneal nerve.

Divide the intermuscular septum between the tibialis anterior and the extensor digitorum longus. Separate the extensores digitorum longus and hallucis longus from the tibialis anterior and keep them apart by hooks. Trace the anterior tibial vessels and the deep peroneal nerve now fully exposed.

The **Anterior Tibial Artery** is one of the terminal branches of the popliteal artery and begins at the lower border of the popliteus. It gains the front aspect of the leg by passing through an aperture in the upper part of the interosseous membrane. It then descends in front of the interosseous membrane lying at first between the tibialis anterior medially and the extensor digitorum longus laterally. Thereafter it lies between the tibialis anterior medially and the extensor hallucis longus laterally. In the lower third of the leg it lies in front of the lower end of the tibia and in front of the ankle is overlapped by the tendon of the extensor hallucis longus which crosses it to gain its medial side. Finally the artery is continued on the dorsum of the foot as the dorsalis pedis artery. The deep peroneal nerve lies on the lateral

side of the artery in its upper third ; in front of the artery in the middle third ; and again on its lateral side in the lower third. Two venæ comitantes accompany the artery. The *branches* given off from the artery in front of the leg are :—(1) The *anterior tibial recurrent artery* which arises from the parent trunk as soon as it reaches the front of the leg. It ascends through the fibres of the tibialis anterior and anastomoses with the inferior genicular branches of the popliteal artery. (2) The *muscular branches* are given off from either side of the artery and supply the muscles in front of the leg. (3) The *anterior medial malleolar artery* (internal malleolar artery) arises from the parent trunk in front of the lower end of the tibia. It passes medialwards behind the tendon of the tibialis anterior and anastomoses on the medial malleolus with the posterior medial malleolar branch of the posterior tibial artery and the medial tarsal branches of the dorsalis pedis. (4) The *anterior lateral malleolar artery* (external malleolar artery) arises a little below the preceding artery. It passes lateralwards behind the tendons of the extensor digitorum longus and the peronæus tertius to the lateral aspect of the lateral malleolus and anastomoses with the perforating branch of the peroneal artery and with the ascending twigs of the lateral tarsal artery.

Anterior tibial lymph gland.—This small lymph gland is sometimes found on the interosseous membrane by the side of the anterior tibial artery at the upper part of the leg.

The **Dorsalis Pedis Artery** is the continuation of the anterior tibial artery on the dorsum of the foot. It commences at a point midway between the two malleoli in front of the ankle-joint and passes forwards to the proximal part of the first intermetatarsal space where it divides into two terminal branches. On its medial side is the tendon of the extensor hallucis longus ; on its lateral

side are the most medial tendon of the extensor digitorum longus and the terminal part of the deep peroneal nerve. It is crossed from the lateral to the medial side by the most medial tendon of the extensor digitorum brevis. Two venæ comitantes accompany it.

Branches.—(1) The *lateral tarsal artery* arises when the parent trunk lies over the navicular bone. It passes lateralwards under cover of the extensor digitorum brevis and anastomoses with the lateral plantar artery, with the arcuate artery in front and with the anterior lateral malleolar and terminal part of the peroneal artery above. (2) The *medial tarsal arteries* are two or three twigs which pass towards the medial border of the foot and anastomose with the anterior medial malleolar artery. (3) The *arcuate artery* (metatarsal artery) passes lateralwards across the bases of the metatarsal bones and anastomoses with the lateral plantar and lateral tarsal arteries. Opposite the second, third, and fourth interosseous spaces it gives off the second, third, and fourth *dorsal metatarsal arteries* respectively. These pass along the corresponding interosseous spaces and each bifurcates opposite the clefts between the toes into two *dorsal digital arteries* to supply the contiguous sides of the corresponding toes. The fourth dorsal interosseus artery gives off a branch which supplies the lateral side of the little toe. Soon after their origin the dorsal metatarsal arteries are joined by the posterior perforating branches of the plantar arch and near the heads of the metatarsal bones, they are joined by the anterior perforating branches of the plantar metatarsal arteries. (4) The *first dorsal metatarsal artery* (arteria dorsalis hallucis) passes forwards on the first interosseous space and, like the other dorsal metatarsal arteries, bifurcates to supply the contiguous sides of the great and second toes. It gives off a branch which supplies the medial side of the great toe. (5) The *deep plantar*

artery is the continuation of the dorsalis pedis artery. It dips between the two heads of origin of the first dorsal interosseous muscle at the back part of the first interosseous space and completes the plantar arch by joining the lateral plantar artery at the sole of the foot.

The *perforating branch of the peroneal artery* (anterior peroneal artery) appears in front of the lower part of the leg by piercing the interosseous membrane about two inches above the lower end of the lateral malleolus. It passes laterally and descends behind the peronæus tertius to the lateral side of the tarsus anastomosing with the anterior lateral malleolar and lateral tarsal arteries.

The **Common Peroneal Nerve** has been traced to the neck of the fibula. Its terminal part lies on the lateral side of the neck of the fibula under cover of the origin of the peronæus longus. It then divides into the superficial and deep peroneal nerves beneath that muscle. It gives off an *articular twig* which ascends with the anterior tibial recurrent artery to supply the knee-joint.

The **Superficial Peroneal Nerve** (musculo cutaneous nerve) descends through the fibres of the peronæus longus to the interval between it and the peronæus brevis, supplies both the muscles and becomes cutaneous by piercing the deep fascia at the lower third of the leg. Its further course and distribution on the dorsum of the foot have been examined (p. 667).

The **Deep Peroneal Nerve** (anterior tibial nerve) passes forwards and downwards through the extensor digitorum longus and reaches the lateral side of the anterior tibial artery at the upper part of the leg. Opposite the middle third of the leg the nerve overlaps the artery and near the ankle again lies to its lateral side. Then it passes behind the transverse crural and cruciate crural

ligaments and, reaching the dorsum of the foot, divides into a medial and a lateral terminal branch. In the leg it gives muscular branches to the tibialis anterior, extensor digitorum longus, peronæus tertius, and extensor hallucis longus. In front of the ankle it gives off an *articular twig* to the joint. The *medial terminal branch* proceeds forwards on the first dorsal interosseous muscle and gives off an interosseous branch which supplies the muscle. It then divides into two dorsal digital nerves which supply the contiguous sides of the great and second toes. The *lateral terminal branch* passes lateralwards beneath the extensor digitorum brevis and presents an enlargement on it like that seen on the dorsal interosseous nerve of the forearm. It ends in the extensor digitorum brevis. Three interosseous branches corresponding to the three lateral interosseous spaces take their origin from the ganglionic enlargement and supply the neighbouring joints. The twig for the second interosseous space sometimes supplies the second dorsal interosseous muscle.

THE BACK OF THE LEG.

Place the limb with its posterior surface uppermost. Flex the ankle over the edge of the table and fix the foot with hooks.

Incisions.—(1) A longitudinal incision along the middle line of the back of the leg up to the end of the heel; (2) a transverse incision at the lower end of the vertical incision along the margins of the foot terminating opposite the lower ends of the malleoli. Reflect the flaps of skin on either side (Fig. 52).

The following structures will be revealed in this dissection :—

Fasciæ { 1. Superficial. 2. Deep and deep transverse. 3. Lacinate ligament.

Muscles	1. 2. 3. Gastrocnemius, soleus, plantaris. 4. 5. 6. 7. Popliteus, tibialis posterior, flexor digitorum longus, flexor hallucis longus.
Nerves	1. Cutaneous. 2. Tibial nerve with its branches.
Vessels	1. Superficial veins. 2. Posterior tibial vessels with their branches.

Superficial Veins.—(1) The *small saphenous vein* has been seen to proceed behind the lateral malleolus after its origin at the lateral end of the dorsal venous arch. It then ascends along the lateral margin of the tendo calcaneus and gradually reaches the middle line of the back of the leg. Thereafter it ascends along the interval between the two heads of the gastrocnemius and pierces the deep fascia over the lower part of the popliteal fossa to terminate in the popliteal vein. (2) The *great saphenous vein* ascends along the medial side of the back of the leg to the thigh.

Cutaneous Nerves.—(1) The *posterior femoral cutaneous nerve.* Its terminal portion accompanies the small saphenous vein and terminates usually at the middle of the back of the leg. (2) The *sural nerve* is formed by the union of the medial sural cutaneous and peroneal anastomotic nerves opposite the middle of the back of the leg. It accompanies the lower part of the small saphenous vein and is then continued along the lateral side of the dorsum of the foot as the lateral dorsal cutaneous nerve. (3) The *saphenous nerve* is seen along the medial side of the back of the leg running in company with the great saphenous vein. (4) The *posterior branch of the medial femoral cutaneous nerve* lies close behind the saphenous nerve and supplies the skin at the upper and medial part of the back of the leg. (5) The *medial calcanean branch* of the tibial nerve pierces the lacinate ligament stretching between

the end of the medial malleolus and the medial side of the heel. It is distributed to the skin of the heel and the sole of the foot.

The **Superficial Fascia** is fatty and is continuous with the superficial fascia of the neighbouring regions.

Remove the fatty superficial fascia and clean the deep fascia.

The **Deep Fascia** of the back of the leg is comparatively thin. Medially it is attached to the medial border of the tibia. Laterally it is continuous with the deep fascia covering the peronæi muscles. Above it is continuous with the deep fascia covering the popliteal fossa. Below, as it lies in the interval between the end of the medial malleolus and the medial margin of the heel, it becomes thickened and forms the lacinate ligament.

Make a vertical incision in the deep fascia along the middle line of the back of the leg, keeping the lacinate ligament in tact. The muscles of the calf are now to be studied.

The **Gastrocnemius** arises by two heads, medial and lateral. The *medial head* is larger and arises from the rough depression above the posterior part of the medial condyle of the femur encroaching upon the adjacent popliteal surface of the bone. The *lateral head* arises from the lateral surface of the lateral condyle of the femur above its posterior end and from the lower part of the lateral epicondylar ridge. The two heads converge and meet together and end in a flattened tendon developed on their anterior aspects which blends about the middle of the leg with the tendon of the soleus to form the tendo calcaneus. The muscle is supplied by the tibial nerve which gives a branch to each head.

Divide the two heads of the gastrocnemius transversely and reflect them upwards. Note that a mucous bursa is interposed between the medial head and the articular capsule. The soleus and plantaris are now exposed.

The **Plantaris** arises (1) from the lateral epicondylar ridge above and medial to the origin of the lateral head of the gastrocnemius and (2) from the oblique popliteal ligament of the knee-joint. The fleshy belly that is formed is three to four inches in length and ends in a long slender tendon which passes obliquely downwards and medialwards between the gastrocnemius and the soleus to gain their medial border. It then descends along the medial border of the tendo calcaneus to be inserted with it into the posterior surface of the calcaneus. Sometimes it is inserted into the deep fascia covering it or is blended with the tendo calcaneus. The muscle is supplied by the tibial nerve.

The **Soleus** is a very thick muscle. It arises (1) from the posterior surface of the head and the upper third of the posterior surface of the body of the fibula; (2) from the popliteal line and the middle third of the medial border of the tibia; and (3) from the fibrous arch which bridges over the posterior tibial vessels between the two bones of the leg. The muscle ends in a thick tendon which blends with the tendon of the gastrocnemius covering it and forms the tendo calcaneus. The muscle is supplied by the tibial nerve.

The **Tendo Calcaneus** (tendo Achillis) is formed by the blending of the tendons of the gastrocnemius and soleus at about the middle of the leg and is the strongest tendon in the body. It passes downwards and expands a little, before its insertion into the middle rough portion of the posterior surface of the calcaneus.

Divide the plantaris. Divide the soleus transversely before its union with the gastrocnemius and reflect the tendo calcaneus downwards. Note the mucous bursa that is interposed between the tendon and the smooth upper portion of the posterior surface of the calcaneus. Divide the attached fleshy mass of the soleus vertically

along the middle line and reflect it on either side by detaching it at its origin from the popliteal line of the tibia

Fig. 125.—Deep dissection of the back of the leg. (Altered from Hirschfeld and Leveille).

A. Peronæus longus.
B. Tibialis posterior.
C. Peronæus brevis.
D. Flexor hallucis longus.
E. Flexor digitorum longus.
F. Tendo calcaneus.
1. Posterior tibial artery.
2. Tibial nerve.
3. Peroneal artery.
4. Medial calcaneal branch (high origin) of posterior tibial artery.
5. Communicating branch of posterior tibial artery.
6. Tendon of tibialis posterior.
7. Tendon of flexor digitorum longus.
8. Termination of posterior tibial artery.
9. Termination of tibial nerve.
10. Tendon of flexor hallucis longus.

and the fibrous arch over the posterior tibial vessels. The deep transverse fascia of the leg separating the superficial from the deep group of muscles is exposed.

The *deep transverse fascia of the leg* is attached medially to the medial border of the tibia and laterally to the posterolateral border of the fibula. Above it is attached to the popliteal line of the tibia. Below it is thick and is continuous with the lacinate ligament.

Remove this layer of fascia keeping the lacinate ligament in tact. Clean the deep muscles of the leg and trace the posterior tibial vessels and the tibial nerve.

The **Flexor Digitorum Longus** arises (1) from the middle two-fourths of the posterior surface of the body of the tibia below the popliteal line and medial to the vertical ridge descending from it; and (2) from the fascia covering the tibialis posterior. The muscle ends in a tendon which passes along the groove behind the medial malleolus with the tendon of the tibialis posterior. It then passes beneath the laciniate ligament into the sole of the foot where it will be subsequently examined. The muscle is supplied by the tibial nerve.

The **Flexor Hallucis Longus** arises (1) from the posterior surface of the body of the fibula below the origin of the soleus, except one inch of its lowest part; (2) from the posterior fibular intermuscular septum; and (3) from the surface of the fascia covering the tibialis posterior. The muscle ends in a tendon which passes through a shallow groove at the back part of the lower end of the tibia and then through a deep groove on the posterior border of the talus and reaches the sole of the foot by passing beneath the laciniate ligament. The muscle is supplied by the tibial nerve.

The *fascia covering the tibialis posterior* is attached medially to the vertical ridge which descends from the popliteal line of the tibia. Laterally it is attached to the posteromedial border of the fibula. Its superficial surface gives origin to the flexores digitorum longus and hallucis longus. Remove this fascia and note that the tibialis posterior takes origin from its deep surface.

The **Tibialis Posterior** lies between the flexor digitorum longus medially and the flexor hallucis longus laterally. It arises (1) from the posterior surface of the body of the tibia extending from the popliteal line above to the junction of the middle and lower thirds of the bone below; (2) from the medial surface of the body of the fibula; (3) from the posterior surface of the interosseous mem-

brane except the last two inches; (4) from the intermuscular septa lying on either side; and (5) from the deep surface of the fascia covering it. The muscle ends in a strong tendon which passes medialwards in front of the tendon of the flexor digitorum longus to the groove on the back part of the medial malleolus. Here it lies medial to the tendon of the flexor digitorum longus and passes under cover of the lacinate ligament to the sole of the foot. The muscle is supplied by the tibial nerve.

The *fascia covering the popliteus* is attached below to the popliteal line of the tibia. Above it receives an expansion from the tendon of insertion of the semimembranosus. Remove this fascia now.

Popliteus. It arises by a tendon, within the capsule of the knee-joint, from the front part of the groove on the lateral surface of the lateral condyle of the femur. This origin will be examined when the joint will be opened. It also arises slightly from the oblique popliteal ligament of the knee-joint. The tendon ends in a triangular muscle which is inserted (1) into the posterior surface of the tibia above the popliteal line and (2) into the deep surface of the fascia covering it. It is supplied by a branch from the tibial nerve which enters its deep surface at the lower border.

The **Posterior Tibial Artery** begins at the bifurcation of the popliteal at the lower border of the popliteus. It passes downwards and medialwards and terminates, at the lower border of the lacinate ligament and midway between the tip of the medial malleolus and the medial margin of the heel, by dividing into the medial and lateral plantar arteries. In the upper two-thirds of its course it is covered by the superficial group of muscles and the deep transverse fascia of the leg. In the lower third it lies superficially being covered by the superficial and deep fasciae and runs along the medial side of the tendo-

calcaneus. From above downwards the vessel lies on the tibialis posterior, the flexor digitorum longus, the lower end of the tibia, and the ankle joint. The tibial nerve lies medial to the artery in the upper third of its course, then crosses the artery superficially and lies on its lateral side in the lower two-thirds. It is accompanied by two venæ comitantes.

Branches.—(1) The ***nutrient artery of the tibia*** arises close to the origin of the parent trunk and enters the nutrient foramen of the tibia just below the popliteal line. (2) The *peroneal artery* arises about an inch below the origin of the parent trunk. It passes downwards and lateralwards towards the fibula lying on the surface of the tibialis posterior. It then descends close to the posteromedial border of the fibula and runs either through a fibrous canal between the tibialis posterior and the flexor hallucis longus or through the fibres of the latter muscle. About two inches above the ankle-joint it emerges from the flexor hallucis longus, passes behind the inferior tibiofibular joint to the lateral surface of the calcaneus where it divides into lateral calcaneal branches. The *branches* given off from the peroneal artery are :—(*a*) ***Muscular*** *branches* which supply the adjacent muscles. (*b*) *Nutrient artery of the* ***fibula*** which enters the nutrient foramen on the posterior surface of the bone. (*c*) ***Perforating*** *branch* (anterior peroneal artery) which pierces the lower part of the interosseous membrane to gain the front aspect of the leg and has already been examined (p. 677). (*d*) *Communicating* ***branch*** which arises about an inch above the ankle-joint and passes transversely medialwards to anastomose with the communicating branch of the posterior tibial artery. (*e*) ***Lateral calcaneal branches*** which are the terminal branches of the peroneal artery and ramify on the lateral and posterior surfaces of the calcaneus anastomosing with the lateral malleolar

arteries. (3) The *muscular branches* supply the soleus and the deep group of muscles. (4) The *communicating branch* arises about an inch above the ankle-joint and passes transversely lateralwards under cover of the flexor hallucis longus to anastomose with the communicating branch of the peroneal artery. (5) The *posterior medial malleolar artery* passes medialwards under cover of the flexor digitorum longus and the tibialis posterior and winds round the medial malleolus to anastomose in front of it with the anterior medial malleolar branch of the anterior tibial artery. (6) The *medial calcaneal branches* arise near the termination of the posterior tibial artery. They pierce the lacinate ligament and supply the skin around the heel and the sole of the foot. (7), (8). The *medial* and *lateral plantar arteries* are the terminal branches and will be traced during the dissection of the sole of the foot.

The **Anterior Tibial Artery** is the smaller of the two terminal branches of the popliteal artery. It passes forwards between the two heads of the tibialis posterior and through the aperture at the upper part of the interosseous membrane to gain the front aspect of the leg where it has been examined. On the back of the leg it gives off two *branches* :—(1) The *posterior tibial recurrent artery* which is not always present. It passes upwards under cover of the popliteus, supplies the tibio-fibular joint and anastomoses with the inferior genicular branches of the popliteal artery. (2) The *fibular branch* passes lateralwards behind the neck of the fibula supplying the adjacent muscles. Sometimes this branch arises from the posterior tibial artery.

Tibial Nerve. The continuation of this nerve from the popliteal fossa should now be traced on the back of the leg. It accompanies the posterior tibial vessels and terminates beneath the lacinate ligament by dividing

into the medial and lateral plantar nerves. Its relation to the posterior tibial artery has been already described. *Branches.*—(1) *Muscular branches* to the soleus, tibialis posterior, flexor hallucis longus, and flexor digitorum longus. (2) *Articular twig* to the ankle-joint. (3) The *medial calcaneal branch* is given off beneath the lacinate ligament. It pierces the ligament and becomes cutaneous. Its distribution has been already examined.

The **Lacinate Ligament** (internal annular ligament) extends from the medial malleolus to the medial margin of the calcaneal tuberosity. It is continuous above with the deep fascia and deep transverse fascia of the leg and below with the plantar aponeurosis. It gives origin to the abductor hallucis and from its medial surface septa are given off which separate the tendons passing beneath it from each other and from the nerve and blood vessels. The structures passing beneath it from the medial to the lateral side are (1) the tendon of the tibialis posterior, (2) the tendon of the flexor digitorum longus, (3) the posterior tibial vessels, (4) the tibial nerve, (5) the tendon of flexor hallucis longus.

Divide the lacinate ligament opposite each tendon and note that each is enclosed by a separate mucous sheath.

THE SOLE OF THE FOOT.

The part should be fixed, with the sole of the foot turned towards the dissector, the heel directed upwards and the front of the ankle resting on a block.

Incisions.—(1) A longitudinal incision from the heel to the root of the middle toe along the middle line of the sole of the foot; (2) a curved incision along the roots of the toes from the medial to the lateral margin of the foot. Reflect the flaps of skin on either side. The skin from

each of the toes should be reflected by a longitudinal incision along the middle line of its plantar surface.

The following structures will be displayed in this dissection :—

Fasciæ	1. Superficial fascia. 2. Plantar aponeurosis.	
Muscles	1. Abductor hallucis. 2. Abductor digiti quinti. 3. Flexor digitorum brevis.	First layer.
	4. Tendon of flexor digitorum longus. 5. Quadratus plantæ. 6. Tendon of flexor hallucis longus. 7. Lumbricales.	Second layer.
	8. Flexor hallucis brevis. 9. Adductor hallucis. 10. Flexor digiti quinti brevis.	Third layer.
	11. Interossei. 12. Tendon of peroneus longus. 13. Tendon of tibialis posterior.	Fourth layer.
Vessels	1. Lateral plantar vessels with their branches including the plantar arch. 2. Medial plantar vessels with their branches.	
Nerves	1. Lateral plantar nerve with its branches. 2. Medial plantar nerve with its branches.	

The **Superficial Fascia** is very thick and contains much granular fat. Fibrous septa pass through it from the skin to the subjacent plantar aponeurosis subdividing the fat into lobules.

Remove the superficial fascia by making a longitudinal incision in it along the middle line of the sole of the foot. While reflecting it note the cutaneous nerve filaments and vascular twigs perforating the plantar aponeurosis at the lines of junction of its intermediate with the lateral and medial portions. Also note the medial calcaneal branch of the tibial nerve ramifying in the superficial